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FUJI ELECTRIC

RS485 USER'S MANUAL

FRENIC Mini SERIES

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MEH448

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COMPACT INVERTER

FRENIC-Mini

User's Manual

for RS485 Communications Card

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Preface

Installing an optional RS485 communications card in the FRENIC-Mini expands the inverter functions, such as operation from a remote keypad. This user's manual describes how to expand these functions. For the operation and handling of the FRENIC-Mini, see the FRENIC-Mini User's Manual and Instruction Manual.

Please read through this user's manual to familiarize yourself with proper use. Improper handling or misuse may result in malfunction, shorter service life or failure.

Listed below are documents relating to the FRENIC-Mini. Consult any appropriate document.

Name	Document number	Description
User's Manual	MEH446	Overview of FRENIC-Mini, how to operate the keypad, control block diagram, selection of peripherals, capacity selection, specifications, function codes, etc.
Catalog	MEH441	Overview of FRENIC-Mini, features, specifications, outline drawing, options, etc.
Instruction Manual	INR-SI47-0791-E	Inspection at the time of product arrival, installation and wiring, how to operate the keypad, troubleshooting, maintenance and inspection, specifications, etc.
Installation Manual	INR-SI47-0773	Inspection at the time of arrival, how to install the product

These documents are subject to revision as appropriate. Obtain the latest versions when using the product.

■ Safety Precautions

Prior to installation, connection (wiring), operation, maintenance or inspection, read through this user's manual as well as the instruction and installation manuals to ensure proper operation of the product. Familiarize yourself with all information required for proper use, including knowledge relating to the product, safety information, and precautions.

This user's manual classifies safety precautions as shown below according to the severity of the accident that may occur if you fail to observe the precaution:

⚠ **WARNING**	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries.
⚠ **CAUTION**	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage.

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

⚠ **CAUTION**
The FRENIC-Mini is not designed for use in appliances and machinery on which lives depend. Consult Fuji before considering the FRENIC-Mini series of inverters for equipment and machinery related to nuclear power control, aerospace uses, medical uses or transportation. When the product is to be used with any machinery or equipment on which lives depend or with machinery or equipment which could cause serious loss or damage should this product malfunction or fail, ensure that appropriate safety devices and/or equipment are installed.

Wiring

⚠ **WARNING**
- Before starting wiring, confirm that the power is turned OFF (open). **An electric shock may result.**

⚠ **CAUTION**
- The product cannot be connected directly to an RS232C interface. - Before connecting wiring to the connector (RJ45 connector) of an RS485 communications card, confirm the wiring of the device to be connected. For further information, see "2.2 Connections" under Chapter 2 of this manual. **Failure may result.**

Operation

⚠ **WARNING**
- Note that the inverter starts to supply power to the motor and the motor runs upon resetting of an alarm with the operation command ON (closed). **An accident may result.**

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CHAPTER 1 OVERVIEW

This chapter describes the functions that can be realized by performing RS485 communications on the FRENIC-Mini.

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1.1 Features

The functions listed below become available by installing an RS485 communications card (option) in the FRENIC-Mini:

- A remote keypad can be mounted on an easy-to-access front of control panel by connecting the remote keypad to the RS485 communications card through an extension cable (option; minimum wiring length: 20m).
- The function code data of the inverter can be edited and the operation status of the inverter can be monitored by connecting it to a personal computer on which inverter support software runs (see the "Inverter Support Software FRENIC Loader Instruction Manual").
- The inverter can be managed and controlled as a subordinate unit (slave) by connecting it to a host controller (master), such as a PLC and a personal computer.

As the communication protocols for controlling inverter, the Modbus RTU widely used by a variety of appliances, and the Fuji general-purpose inverter protocol common to Fuji's inverters including conventional models, are available.

Modbus RTU protocol

The Modbus RTU protocol is a set of communications specifications defined to connect Modicon's PLCs in a network. A network is established between PLCs or between a PLC and another slave unit(s) (inverter(s), etc.). The main functions include:

- supporting both a query-response format and a broadcast format for messages;
- enabling the host computer as the master to transmit queries to each inverter as a slave, and each slave to send back responses to the queries to the master;
- supporting RTU and ASCII modes as transmission modes in the standard Modbus protocol, whereas the FRENIC-Mini supports only RTU mode that provides a high transmission density; and
- performing an error check through a CRT (cyclic redundancy check) to ensure accurate data transmission.

Fuji general-purpose inverter protocol

This protocol is commonly used for all models of Fuji's general-purpose inverters. The main functions include:

- enabling, as a common protocol, operation of all models of Fuji's general-purpose inverters with the same host program (function codes cannot be generally edited because specifications are different among models);
- adopting a fixed-length transmission frame (standard frame) to facilitate program development for the host; and
- reducing the communications time in response to operation commands and frequency setting requiring quick response by using an optional transmission frame.

CAUTION

- The remote keypad uses a dedicated protocol. By connecting the remote keypad, the protocol automatically switches to the dedicated protocol; thereby the setting of communications-related functions is not required.
- Although the personal computer loader uses a dedicated protocol for loader commands, part of the communications conditions must be set. (For further information, see the "Inverter Support Software FRENIC Loader Instruction Manual.")
- With regard to a FRENIC-Mini that uses inverter ROM 0399 or earlier version, part of the RTU protocol functions are restricted. Contact us for these restrictions.
  Confirm the ROM version according to the menu "*5_14*" described in "3.8 Reading Maintenance Information" under Chapter 3 of the FRENIC-Mini Instruction Manual.

1.2 List of Functions

The functions listed below become available by operating the appropriate function codes from the host controller.

The chapters that follow describe these functions in detail.

Table 1.1 List of RS485 communications functions

Function	Description	Related function code
Operation	The functions equivalent to the terminal functions shown below can be executed through communications: -Forward operation command "FWD" and reverse operation command "REV" -Digital input commands ([FWD], [REV], [X1] - [X3] terminals) -Alarm reset command ("RST")	S codes (dedicated to communi-cations)
Frequency setting	Either of the following two setting methods can be selected: -±20000/maximum output frequency -Frequency (adjustable unit: 0.01 Hz) without polarity	
PID command	-Setting within ±20000/100%	
Operation monitor	-Frequency command -Actual values (frequency, current, voltage, etc.) -Operation status, information on general-purpose output terminals, etc.	M codes
Maintenance monitor	-Cumulative operation time, DC link-circuit voltage -Information to determine the service life of parts to be periodically replaced (main circuit capacitor, PC board capacitor, cooling fan) -Model codes, capacity codes, ROM version, etc.	W codes X codes Z codes
Alarm monitor	-Monitoring alarm history (last three alarms) -Monitoring information when an alarm occurs (last three alarms) Operation information (output/set frequencies, current, voltage, etc.) Operation status, information on general-purpose output terminals Maintenance (cumulative operation time, DC link-circuit current, heat sink temperature, etc.)	(dedicated to communica-tions)
Function code	Monitoring and changing function code data	All function codes other than above

CHAPTER 2
COMMON SPECIFICATIONS

This chapter describes the specifications common to both of the Modbus RTU and Fuji general-purpose inverter protocols. For further information about the specific specifications of each protocol, see Chapter 3 "Modbus RTU Protocol" and Chapter 4 "Fuji General-purpose Inverter Protocol."

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2.1 List of Specifications

Shown below are the specifications for RS485 communications of the FRENIC-Mini:

Table 2.1 List of RS485 communications specifications of the FRENIC-Mini

Item	Specification		
Protocol	FGI-BUS	Modbus RTU	Loader commands
Complying with	Fuji general-purpose inverter protocol	Modicon's Modbus RTU (RTU mode only)	Special commands dedicated to inverter support software (not disclosed)
Number of units to be connected	1 host and 31 inverters		
Electrical specification	EIA RS485		
Method of connection to RS485	Using 8-pin RJ45 connectors		
Synchronization system	Start-stop synchronization		
Communication system	Half-duplex system		
Baud rate (bps)	2400, 4800, 9600, and 19200		
Maximum communications distance	500m		
Number of stations	1 to 31	1 to 247	1 to 255
Frame type	FGI-BUS	Modbus RTU	Loader command
Frame synchronization system	Header character detection (SOH)	Data absence time detection (for three bytes)	Header character detection (start code 96_H)
Frame length	General transmission: 16 bytes, fixed High-speed transmission: 8 bytes or 12 bytes	Variable length	Variable length
Maximum data to be transferred	During writing: 1 word During reading: 1 word	During writing: 50 words During reading: 50 words	During writing: 41 words During reading: 41 words
Message system	Polling, selecting, and broadcast		Command message
Character system	ASCII	Binary	Binary
Character length	8 bits or 7 bits selectable according to function code	8 bits, fixed	8 bits, fixed
Parity	Even, odd or without parity selectable according to function code		Even parity
Stop bit length	1 bit or 2 bits selectable according to function code	When "without parity" selected: 2 bits When "with parity" selected: 1 bit	1 bit, fixed
Error check system	Check sum	CRC-16	Check sum

2.2 Connections

2.2.1 Basic connection diagrams

Use a standard LAN cable (straight cable for 10BASE-T) to connect the FRENIC-Mini to a host controller, such as a personal computer and a PLC, through an RS485 communications card. A converter is required to connect the FRENIC-Mini to a host controller without RS485 interface.

Multi-drop connection

Use a branch adapter for multi-drops as shown below to connect the FRENIC-Mini to a host by multi-drop connection.

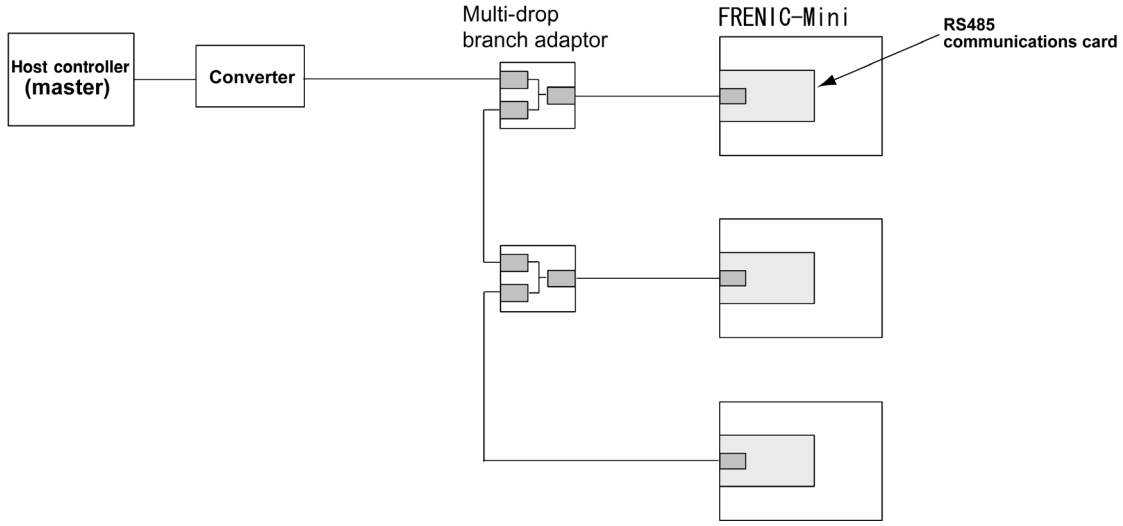


Figure 2.1 Multi-drop connection diagram

CAUTION

- Select branch adapters for multi-drops and converters according to "2.2.3 Device for connection" to prevent damage to or malfunctioning of control PC boards due to external noise and to remove the effects of common mode noise.
- The total length of wiring must not exceed 500 meters.
- The power supply for remote keypad is provided with the RJ45 connector of the RS485 communications card. Do not use the pins assigned to the power supply when connecting another device to this connector. (See Figure 2.3.)

Connecting a remote keypad

Use an eight-core straight cable (extension cable for remote operation, type CB-5S) to connect the FRENIC-Mini to a remote keypad.

Figure 2.2 Connecting a remote keypad

CAUTION

- The total length of wiring must not exceed 20 meters.
- Turn OFF the terminating resistor of the RS485 communications card. For further information, see the section of **Terminating resistor** under "2.2.2 Connection procedures."

2.2.2 Connection procedures

This section describes the necessary knowledge to connect the FRENIC-Mini to a host controller.

RJ45 connector pin layout

To facilitate connection with a standard RS232C-RS485 converter, the FRENIC-Mini adopts two pairs of pins of RJ45 LAN connector pins complying with a four-pair layout, with pin No. 4 assigned to DX- signals and pin No. 5 to DX+ signals.

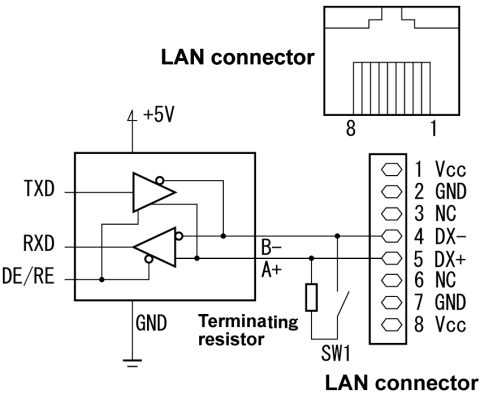


Figure 2.3 FRENIC-Mini's pin layout

CAUTION

- Pin Nos. 1, 2, 7, and 8 are assigned to the power supply for the remote keypad. Do not use these pins when connecting this RS485 communications card to another device.
- To connect the FVR-E11S series inverter on the communications network on which the FRENIC-Mini exists, pin Nos. 3 and 5 must be switched using a connection cable, etc. Table 2.2 makes a comparison of pin layout between the FRENIC-Mini and the FVR-E11S series.

Table 2.2 Comparison of pin layout between the FRENIC-Mini and the FVR-E11S

Pin No.	FRENIC-Mini	FVR-E11S	Remarks
1	VCC (+5V)	SEL_TP (keypad selected)	The power supply is short-circuited when connected.
2	GND	GND	
3	NC	DX+	
4	DX-	DX-	
5	DX+	SEL_ANY (optional)	
6	NC	GND	
7	GND	VCC	The power supply is short-circuited when connected.
8	VCC (+5V)	VCC	

Cable specifications

Connect only pin Nos. 4 and 5 using a standard LAN cable (a straight cable for 10BASE-T that meets the standards of U.S. ANSI/TIA/EIA-568A Category 5).

Terminating resistor

Insert a terminating resistor (100 to 120Ω) into both ends of the wiring, which can suppress the reflection of signals and reduce noise. This RS485 communications card contains a 120Ω terminating resistor that can be inserted and open with the SW1.

Terminating resistors can be inserted by turning ON the SW1 shown in Figure 2.4.

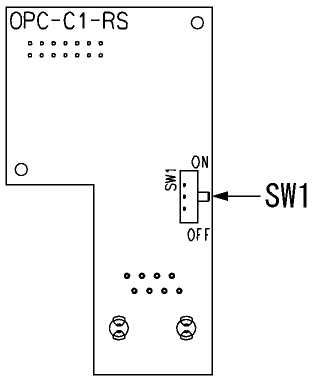


Figure 2.4 SW1 of the RS485 communications card

CAUTION Insert a terminating resistor into the terminal master unit and the slave unit (inverter) connected to the last end, or both terminal units comprising the network. This means that a terminating resistor is inserted into a total of two units. Note that inserting a terminating resistor into three or more units may cause a shortage of signal current capacity.

Connecting a four-wire RJ45 to a host controller

Although the FRENIC-Mini uses two-wire cables, some hosts adopt four-wire cables. The FRENIC-Mini can be connected to such a host with a two-wire cable by connecting the driver outputs and receiver inputs of the host with a crossover cable.

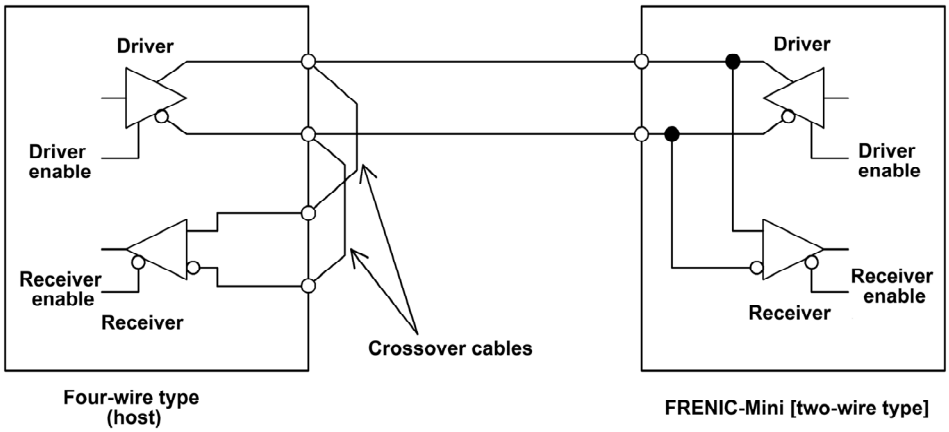


Figure 2.5 Connecting the FRENIC-Mini to a four-wire type host

CAUTION
- The host must have the function to set the driver outputs to high impedance (driver enable). Confirm that products conforming to RS485 are provided with this function.
- Keep the driver outputs in the status of high impedance except when the host is transmitting data (driver enable: OFF).
- Keep the receiver in the host deactivated (receiver enable: OFF) during transmission to prevent the host from receiving the data it has transmitted. If the receiver cannot be deactivated, program the host so that it will discard the data it transmits.

2.2.3 Device for connection

This section describes the devices that are necessary for the connection of the FRENIC-Mini to a host without RS485 interface, such as a personal computer, or for multi-drop connections.

[1] Communications level converter

In general, personal computers are not equipped with an RS485 port. An RS232C-RS485 communications level converter (hereinafter referred to as "RS232C-RS485 converter" or "converter") is, therefore, required. Use a converter that meets the following recommended specifications for proper operation. Note that proper performance may not be expected from a converter other than the recommended one.

Recommended communications level converter specifications

Transmission/receiving switching system: Automatic switching by monitoring data transmitted on the personal computer (RS232C)

Isolation: The converter must be isolated from the RS485 side.

Failsafe: Equipped with a failsafe function (*)

Other requirements: The converter must have excellent noise immunity.

* The failsafe function means a function that enables the RS485 receiver output to ensure the status of logic high even when the RS485 receiver input is open or short-circuited or when all of the drivers of the RS485 are inactive.

Recommended communications level converter

System Sacom-made KS-485PTI

Transmission/receiving switching system

Since the RS485 communications card for the FRENIC-Mini adopts a half-duplex system (two-wire system), the converter to be used must have a transmission/receiving switching function. The following two switching systems are available:

(1) Automatic switching by monitoring transmitted data

(2) Switching by RS232C control signals (RTS or DTR), (flow control)

Personal computer loaders do not support the switching system of (2). Use a converter adopting the switching system described in (1).

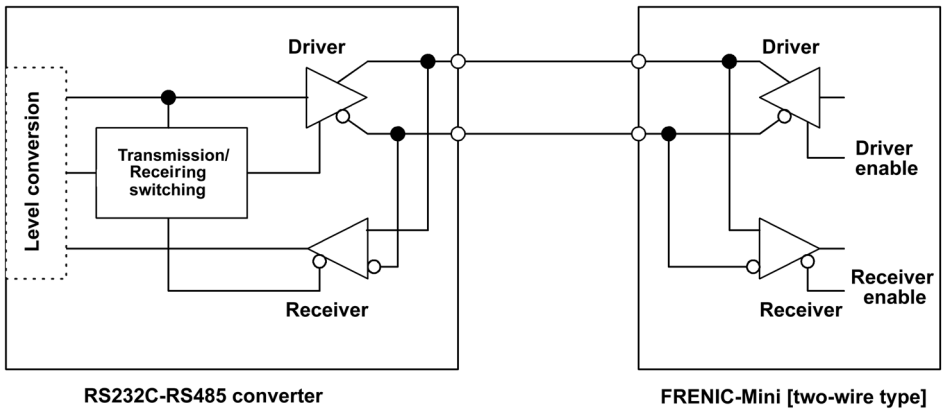


Figure 2.6 Communications level conversion

[2] Branch adapter for multi-drops

The FRENIC-Mini uses an RJ45 connector for the communications connector, therefore, requires a branch adapter for the RJ45 connector to make a multi-drop connection.

Recommended branch adapter

SK Kohki-made MS8-BA-JJJ

2.2.4 Measures against noise

Depending on the operating environment, the FRENIC-Mini may not ensure normal communications due to noise generated by the inverter, or any of the instruments and converter of the master may malfunction. This section describes measures to be taken against such problems. Consult Appendix A "Advantageous Use of Inverters (Notes on electrical noise)" to the FRENIC-Mini User's Manual as well.

[1] Measures for devices subjected to noise

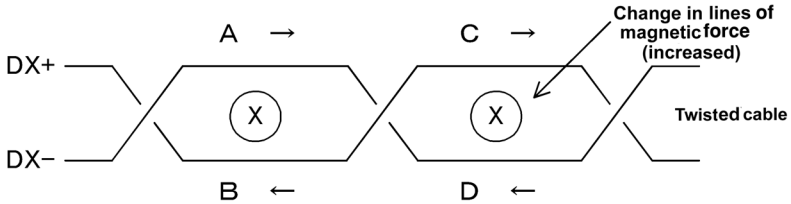
Isolated converter

Eliminate common mode noise that exceeds the specified operating voltage range of the receiver in case of long-distance wiring. However, since the isolated converter itself may malfunction, use a converter insusceptible to noise.

Category 5 compliant LAN cable

Category 5 compliant LAN cables are generally used for RJ45 connector wiring. To obtain an improved preventive effect on electromagnetically induced noise, use Category 5 conformed four-pair twisted pair LAN cables, DX+ and DX- in pairs (twisted pairs). To ensure a high preventive effect on electrostatically induced noise, use Category 5 conformed four-pair shielded twisted pair LAN cables, with the master-side end of the shield grounded.

Effect of twisted pair cables



A uniform magnetic flux directing from the face to back of the paper exists, and if it varies (increases), electromotive force in the direction of → is generated. The electromotive forces of A to D are the same in intensity and flow in the directions shown in the above figure. In the cable DX+ in this case, electromotive forces B and C flow in the opposite directions and offset each other, and so do electromotive forces A and D in the cable DX-. So, normal mode noise caused by electromagnetic induction does not occur. However, noise cannot be completely suppressed under such conditions as an uneven twist pitch. Thus, noise is eliminated in twisted cables but normal mode noise occurs in parallel cable.

Shield effect

1) When the shield is not grounded,
   the shield functions as an antenna and receives noise.
2) When the shield is grounded at both ends,
   if the grounding points are separated from each other, the ground potential may be different between them, and the shield and the ground form a loop circuit in which a current flows and may cause noise. Additionally, the magnetic flux within the loop may vary and generate noise.
3) When the shield is grounded at either end,
   the effect of electrostatic induction can be completely eliminated within the shielded section.

Terminating resistor

Insert a resistor equivalent to the characteristic impedance of the cables (100 to 120Ω) into both end terminals of the wiring (network) to prevent ringing due to the reflection of signals.

Separation of the wiring

Separate the power lines (input R, S, and T and output U, V, and W) and the RS485 communications line from one another because induced noise can be prevented.

Separation of grounding

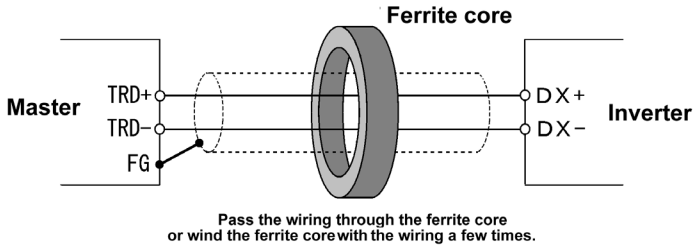
Do not ground instruments and the inverter together. Noise may conduct through the grounding wire. Use as a thick wire as possible for grounding.

Isolation of the power supply

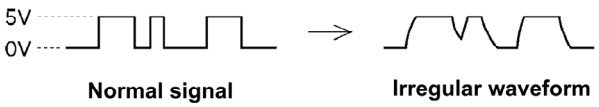
Noise may carry through the power supply for instruments. It is recommended that the distribution system be separated or a power isolation transformer (TRAFY) or noise suppression transformer be used to isolate the power supply for such instruments from the power supply for the inverter.

Adding an inductance

Insert a chalk coil in series in the signal circuit, or pass the signal wiring through a ferrite core, as shown in the figure below. This provides the wiring higher impedance against high-frequency noise, and suppresses the propagation of high-frequency noise.



CAUTION If an inductance is added, the signal waveform may become irregular and a transmission error may result during communications at a high baud rate. In this case, reduce the baud rate by changing the setting of function code y04.



[2] Measures against noise sources

Carrier frequency

By reducing the setting of function code F26 "motor sound (carrier frequency)," the noise level can be reduced. However, reducing the carrier frequency increases the running noise level of the motor.

Installing and wiring an inverter

Passing the power lines through metal conduit or adopting metal control panels can suppress radiation or induction noise.

Isolating the power supply

Using a power isolation transformer as the power for the inverter can cut off the propagation (transmission) of noise.

[3] Measures to reduce the noise level

Consider using a zero-phase reactor or EMC filter. The measures described in [1] and [2] above can generally prevent noise. However, if the noise of the equipment does not decrease to the permissible level, consider measures to reduce the noise level. For further information, see "6.4.1 Peripheral Equipment Options" under Chapter 6 of the FRENIC-Mini User's Manual.

2.3 Switching Communications

2.3.1 Commands for switching communications

Figure 2.7 below shows a block diagram via communications, including the systems for frequency setting and operation commands.

This block diagram is part of the switching section, and there are configuration settings that are given priority over the blocks illustrated here. For further information about blocks, including peripheral devices, see “Chapter 4 BLOCK DIAGRAM FOR CONTROL LOGIC” of the FRENIC-Mini User's Manual.

CAUTION Operation commands herein include via-communications digital input signals.

According to the setting of function code H30 link function (operation selection), the command system when communications is valid is selected.

Even if digital input is set to link operation, while making the link invalid ("LE" = OFF), the command system switches from communications to other settings including digital input signal. The frequency setting, the forward operation command, and the X1 signal shown in Figure 2.7 switch from S01, S05, and S06 to [12], [FWD], and [X1], respectively.

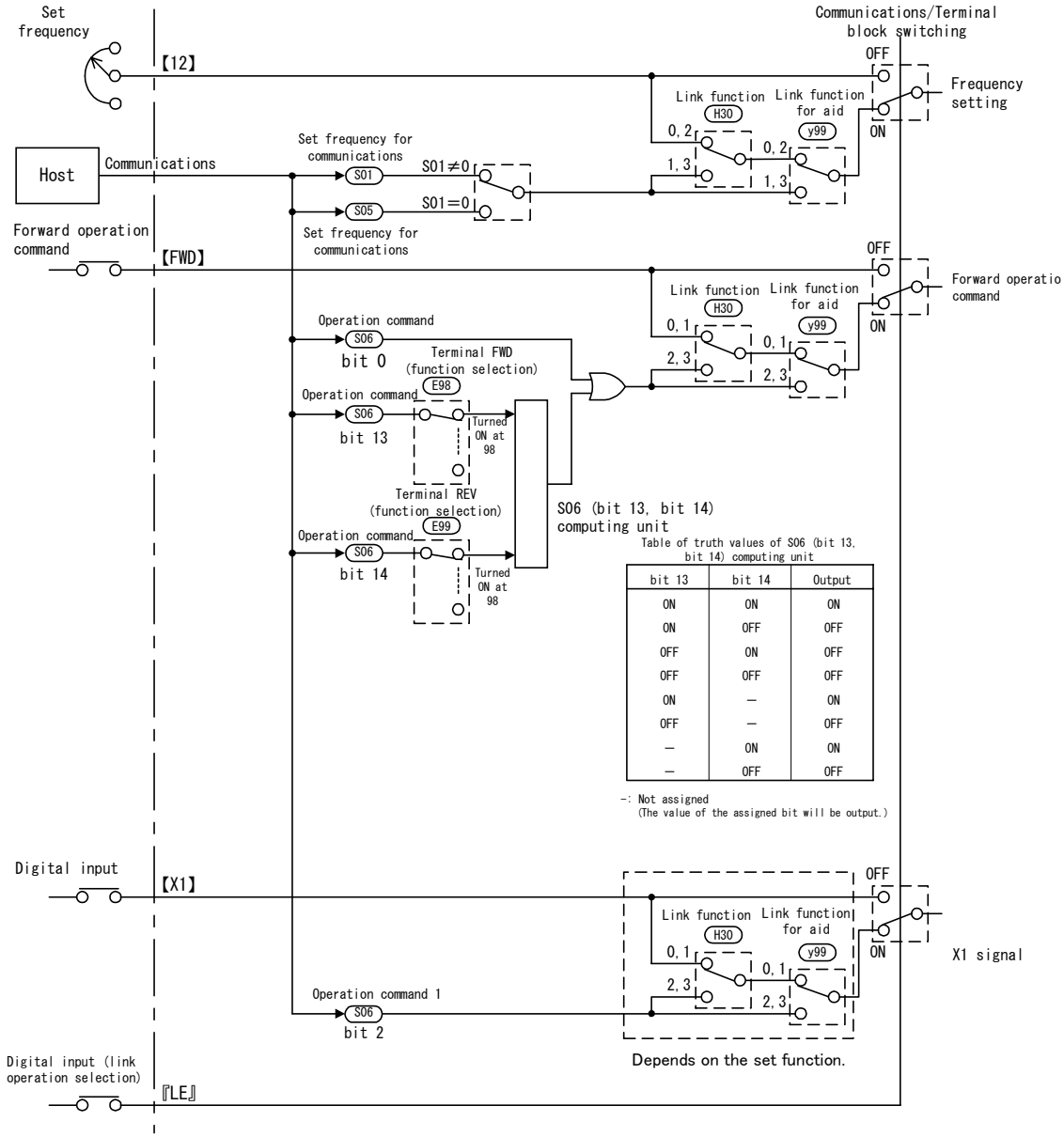


Figure 2.7 Operation command block diagram via communications

2.3.2 How to switch communications enabled/disabled

To issue a frequency setting or via-communications operation command and thereby control the inverter, select 1, 2 or 3 of function code H30: Serial link (function select).

For switching between via-communications control and control from the terminal block (external signal input) (frequency setting from terminal [12], operation command from terminal [FWD], etc.) and between remote operation and keypad operation, assign link operation selection (data = 24: “LE”) to any digital input terminal-related function code of (E01 – E03: [X1] – [X3] terminals, E98: [FWD] terminal, E99: [REV] terminal). Link operation selection can be switched with the assigned terminal.

Communications automatically becomes valid when link operation selection is not assigned to any digital input terminal.

Table 2.3 Digital input terminal settings and communications statuses

Input terminal	Status
OFF	Communications invalid
ON (short-circuited to the terminal [CM])	Communications valid

CAUTION
- Via-communications command data and operation data must be rewritten from the host (controller) because the memory is initialized when the power is turned ON.
- Although command data and operation data can be written even if communications is invalid, they will not be validated because the switch is made invalid by link operation selection. If communications is made valid with no operation data written (operation command OFF, frequency setting = 0Hz) during operation, the running motor decelerates to a stop and may exert impact on the load depending on the set deceleration time. Operation can be switched without causing impact to the load by setting data in communications invalid mode in advance and then switching the mode to valid.
- If negative logic is set as Link enable (data 1024), the logical value corresponding to the ON/OFF status of the command "LE" will be reversed.

2.3.3 Link functions (operation selection)

According to the setting of function code H30: Serial link (function select), the frequency setting and the operation command source (via-communications command or command from the external signal input) when communications is valid can be selected.

Table 2.4 Link function (operation selection)

Link function H30	When communications is valid	
	Frequency setting	Operation command
0	External signal input valid (frequency setting 1, 2)	External signal input valid (Operation command by F02) (Terminal block digital input valid)
1	Communications valid (S01, S05)	
2	External signal input valid (frequency setting 1, 2)	Communications valid (S06)
3	Communications valid (S01, S05)	

HINT By selecting continuous communications valid without setting any digital input terminal, and switching the data of H30 to communications valid/invalid (external signal input valid), communications valid/invalid can be switched in the same manner as switching at the digital input terminal.

2.3.4 Link functions for supporting data input (operation select)

According to the setting of function code y99: link function for supporting data input (operation select), the frequency setting and the operation command source (via-communications command or command specified by H30) when communications is valid can be selected individually.

CAUTION
- This function code is designed for inverter support software for personal computer loaders such as FRENIC Loader, and forcibly makes communications valid without changing the setting of H30. Do not change the current setting unless otherwise required.
- This function code, if changed from the inverter, provides the function equivalent to y99 = 0. The data of y99 must be written from communications when setting it to a value other than 0.
- The data of this function code cannot be saved in the inverter and will return to 0 when the power is turned OFF.

Table 2.5 Link functions for supporting data input

Link function y99	When communications is valid	
	Frequency setting	Operation command
0	Frequency setting specified by H30	Operation command specified by H30
1	Communications valid (S01, S05)	
2	Frequency setting specified by H30	Communications valid (S06)
3	Communications valid (S01, S05)	

2.4 Making RS485-related Settings

2.4.1 Link function (RS485 setting)

Use function codes (y01 – y10) to make settings for RS485 communications functions.

Station address (y01)

Set a station address for RS485 communications. The setting range depends on the protocol.

Table 2.6 y01: RS485 setting (station addresses)

Protocol	Range	Broadcast
Modbus RTU protocol	1 to 247	0
Protocol for loader commands	1 to 255	-
Fuji general-purpose inverter protocol	1 to 31	99

CAUTION
- Response does not occur if a value out of the specified range is set.
- Match the station address with that of the personal computer when a personal computer loader is connected.

Mode selection on no response error (y02)

Set the action to be performed when an RS485 communications error occurs.

Table 2.7 y02: RS485 setting (in case of error)

Data	Function
0	When RS485 communications error occurs, the ongoing operation is immediately interrupted by the alarm *"Er8"*.
1	When RS485 communications error occurs, the ongoing operation is interrupted by the alarm *"Er8"* after operation is performed for the period of time set by the timer.
2	When RS485 communications error occurs, the ongoing operation is interrupted by the alarm *"Er8"* if communications are retried during operation for the period of time set by the timer but is not recovered.
3	The ongoing operation continues even if a communications error occurs.

CAUTION If the personal computer goes out of control when a personal computer loader is connected and its trial operation function is used, a stop command may not be issued. In this case, it may be impossible to deactivate the inverter. To ensure safety, select the appropriate setting in case of occurrence of communications error.

Timer (y03)

Set an error processing time.

- Data setting range: 0.0 to 60.0 (seconds)

Baud rate (y04)

Set a baud rate.

- Setting when a personal computer loader is connected
  Match the baud rate with that of the personal computer.

Table 2.8 Baud rate

Data	Baud rate
0	2400 bps
1	4800 bps
2	9600 bps
3	19200 bps

Data length (y05)

Set a character length.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to eight bits (as in the Modbus RTU protocol).

Table 2.9 Data length

Data	Function
0	8 bits
1	7 bits

Parity check (y06)

Set a parity bit.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to even parity.

Table 2.10 Parity check

Data	Function
0	No parity bit
1	Even parity
2	Odd parity

Stop bits (y07)

Set a stop bit.

- Setting when FRENIC Loader is connected
  This code does not need to be set because it is automatically set to 1.

- In the Modbus RTU protocol, this code does not need to be set because it is automatically determined in conjunction with the parity bit.

Table 2.11 Stop bits

Data	Function
0	2 bits
1	1 bit

No response error detection time (y08)

In a system designed to access a station (inverter) regularly controlled by the host within a specific period of time, access may be lost during RS485 communications due to wire disconnection. Set the period of the time when the inverter detects it until when the ongoing operation is interrupted by an alarm with RS485 communications error "*Er8*."

Table 2.12 No response error detection time

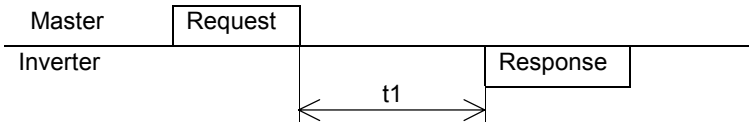
Data	Function
0	No response error detection disabled
1 to 60	Detecting time from 1 to 60 seconds

- Setting when FRENIC Loader is connected
  Communications from FRENIC Loader to the inverter takes place at fixed intervals or only when an event occurs as a result of operation, depending on the functions selected. For this reason, select the setting of disabling communications interruption detection (data = 0).
  (For example, although communications is performed at a fixed cycle of approximately 800ms during trial operation, the cycle varies according to the processing by the operating system of the personal computer.)

Response interval (y09)

Set the time from the completion of receipt of a request from the personal computer or PLC, to the return of response to it. Even in a slow processing device, timing can be adjusted by changing the response interval time.

- Data setting range: 0.00 to 1.00 (second)



t1 = Response interval time + α

α: The processing time within the inverter. It depends on the timing and command given.
For further information, see the procedure for each protocol on the host below:
Modbus RTU protocol → Chapter 3 "3.2 Host Side Procedures"
Fuji general-purpose inverter protocol → Chapter "4.2 Host Side Procedures"

- Setting when FRENIC Loader is connected
Set the response interval time according to the performance and conditions of the personal computer and converter (RS485/RS232C converter, etc.).
(Some converters monitor the communications status and use a timer to switch transmission/receiving.)

Protocol select (y10)

Select a communications protocol.

- Setting when FRENIC Loader is connected
Select the protocol for FRENIC Loader commands (y10 = 1).

Table 2.13 Protocol select

Data	Protocol
0	Modbus RTU
1	FRENIC Loader
2	Fuji general-purpose inverter

CHAPTER 3

Modbus RTU PROTOCOL

This chapter describes the Modbus RTU protocol, as well as the host side procedure for using this protocol and error processing.
The Modbus RTU protocol was a set of specifications developed in the United States. For the FRENIC-Mini of which inverter ROM version is 0399 or earlier, the Modbus RTU functions are partially restricted. Contact us about details of restrictions. Check the inverter ROM version with menu "*5_14*" described in "3.8 Reading Maintenance Information" under Chapter 3 of the FRENIC-Mini Instruction Manual.

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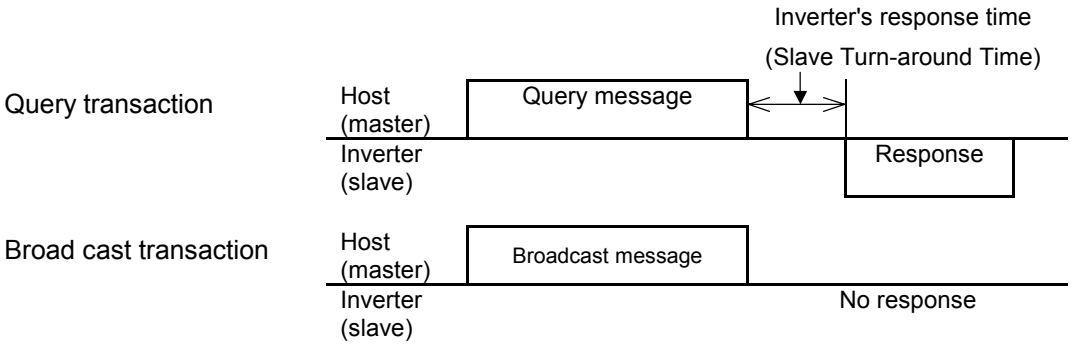
3.1 Messages

3.1.1 Message formats

The regular formats for transmitting RTU messages are shown below:



If the inverter receives from the host a message in the standby status and considers it properly received, it executes a transaction in response to the request and sends back normal response.
If the inverter judges that the message has not been received properly, it returns error response.
The inverter does not send back any response in the case of broadcast transactions.

3.1.2 Message types

Message types are classified into four types; query, normal response, error response, and broadcast.

Query

The host sends messages to a single inverter.

Normal response

After the inverter received a query from the host, the inverter executes a transaction in response to the request, and sends back corresponding normal response.

Error response

If the inverter receives a query but cannot execute the requested function because an invalid function code is specified or for other reasons, it sends back error response.
The error response is accompanied by a message describing the reason the request cannot be executed.
The inverter cannot send back any response in case of a CRC or physical transmission error (parity error, framing error, overrun error).

Broadcast

The master uses address 0 to send messages to all slaves. All slaves, which receive a broadcast message, execute the requested function. This transaction will be terminated upon timeout of the master.

3.1.3 Message frames

As shown below, a transmission frame consists of four blocks, which are called fields. Details depend on RTU function codes. To make a clear distinction between RTU function codes and the inverter's function codes, the former will be hereinafter referred to as FCs.

1 byte	1 byte	Up to 105 bytes	2 bytes
Station address	FC (RTU function code)	Information	Error check

Station address

The station address field is one byte long, in which a station address between 0 and 247 can be selected.
Selecting address 0 means the selection of all slave stations and a broadcast message.

FC (RTU function code)

The FC field is one byte long, in which a function code is defined with a number from 0 to 255. The FCs in hatching are available. Do not use any unavailable FC. Failure to observe this rule results in error response.

Table 3-1 List of FCs

FC	Description
0 to 2	Unused
3	Function reading (up to 50)
4 to 5	Unused
6	Single function writing
7	Unused
8	Maintenance code
9 to 15	Unused
16	Serial function writing (up to 50 data)
17 to 127	Unused
128 to 255	Reserved for exception response

Information

The information field contains all information (function code, byte count, number of data, data, etc.). For further information about the information field for each message type (broadcast, query, normal response, error response), see "3.1.4 Message categories."

Error check

The error check field is a CRC-16 check system and two bytes long. Since the length of the information field is variable, the frame length required for calculating the CRC-16 code is calculated based on the FC and the byte count data.
For further information about CRC-16 calculations and algorithm, see "3.4 CRC-16."
For byte counts, see "3.1.4 Message categories."

Character format

Each byte of a message is transmitted as a character. Character formats are described on the following page.
A character comprises a start bit (logical value 0), 8-bit data, an additional (optional) parity bit, and a stop bit (logical value 1).

A character always consists of eleven bits, and the number of stop bits varies depending on whether parity exists.

Without parity

LSB										MSB
0	1	2	3	4	5	6	7	8	9	10
Start	Data								Stop	

With parity

LSB										MSB
0	1	2	3	4	5	6	7	8	9	10
Start	Data								Parity (optional)	Stop

3.1.4 Message categories

There are five RTU message categories; function reading, single function writing, serial function writing, maintenance code, and error response.
Each category is described below:

[1] Reading function codes

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	03_H	Function code	Number of data read	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	1 byte	2 to 100 bytes	2 bytes
Station address	03_H	Byte count	Number of data read	Error check
			Hi, Lo (data 0); Hi, Lo (data 1); ·····	

How to set a query

- This request is not available for broadcast transactions. Station address 0 will become invalid (no response).
- FC = 3 (03_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).

(Example) When the function code is E15, the Hi byte is 01_H and the Lo byte is $0F_H$.

Table 3.2 Function code group/code conversion table

Group	Code		Name	Group	Code		Name
F	0	00_H	Fundamental function	M	8	08_H	Monitor data
E	1	01_H	Extension terminal function	J	13	$0D_H$	Application function
C	2	02_H	Control function of frequency	y	14	$0E_H$	Link function
P	3	03_H	Motor parameter	W	15	$0F_H$	Monitor 2
H	4	04_H	High performance function	X	16	10_H	Alarm 1
S	7	07_H	Command/ Function data	Z	17	11_H	Alarm 2

- The length of the read data is up to 50 words (2 byte each).
- If the read data contains an unused function code, 0 will be read, which will not result in an error.
- Data does not extend over two or more function code groups. If, for example, reading of 40 words is specified from F40 but only function codes up to F40 are available, the data of F40 will be set at the first word, and the other 49 words will be 0.

Interpretation of normal response

- The data range of byte counts is between 2 and 100. A byte count is double the number of data read (1 - 50 data) of the response.
- The read data contains each word data in order of Hi byte and Lo byte, and each word data is sent back in order of the data of the function code (address) requested by the query, the data of that address number plus 1, the data of that number address number plus 2 ... If two or more function data are read and the second or any of the following data contains an unused function code (F09, etc.), the read data will become 0.

[2] Single function writing

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06_H	Function code	Data written	Error check
		Hi Lo	Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	06_H	Function code	Data written	Error check

How to set a query

- When address 0 is selected, broadcast is available. In this case, all inverters do not respond even if a broadcast request is executed.
- FC = 6 (06_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).
- The written data field is fixed two bytes long. Set the data on the function code to be written.

Interpretation of normal response

The frame is the same as the query.

[3] Serial function writing

Query

1 byte	1 byte	2 bytes	2 bytes	1 byte	2 to 100 bytes	2 bytes
Station address	10_H	Function code	Number of data written	Byte count	Data written	Error check
		Hi Lo	Hi Lo		Hi, Lo; Hi, Lo…	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	10_H	Function code	Number of data written	Error check

How to set a query

- When the station address 0 is selected, broadcast is available. In this case, all inverters do not respond even if a broadcast request is executed.
- FC = 16 (10_H)
- The function code is two bytes long. The Hi byte indicates the function code group (see Table 3.2), and the Lo byte represents a function code identification number (0 to 99).
- The number of data written is two bytes long, and the setting range is from 1 to 50. If 51 or a higher value is set, error response will result.
- The byte count field is one byte long, and the setting range is from 2 to 100. Set a value equivalent to the double of the number of data written.
- Set the lowest order code (the data on the function code requested by the query) at the first two bytes of the data written, and the higher order data (address plus 1, address plus 2 ...) at the following bytes.
- If the data written contains an unused function code, the writing will be ignored, which will not result in an error.

Interpretation of normal response

- With regard to the function code and the number of data written, the same values as those of the query will be sent back.

CAUTION - When H03 (Data initialization) is used, use single function writing (FC = 6). H03 will be ignored even if it is written with serial function writing (FC = 16).

[4] Maintenance code

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08_H	Diagnosis code 0000_H	Data written	Error check
			Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station address	08_H	Diagnosis code 0000_H	Data written	Error check

How to set a query

- This request cannot use broadcast. Station address 0 will become invalid (no response).
- FC = 8 (08_H)
- Set the diagnosis code field to be 2 bytes long fixed 0000_H. Error response will result if data other than 0000_H is set.
- The data written field is two bytes long, and any contents of data can be set.

Interpretation of normal response

- The frame is the same as the query.

[5] Error response

If the inverter receives an improper query, it will not execute it, which will result in error response.

Error response

1 byte	1 byte	1 byte	2 bytes
Station address	Exception function	Subcode	Error check

Interpretation of error response

- The station address is the same as that of the query.
- The exception function is a value obtained by adding 80H to the FC of the query message (or the value of the FC if the FC is larger than 80H).
  For example, when the FC is 3, the exception function is 3 + 128 = 131 (83_H).
- The subcode represents the code of the reason for the improper query.

Table 3.3 Subcodes

Subcode	Item		Description
1	Improper FC		An FC other than 3, 6, 8 or 16 was received.
2	Improper address	Improper function code	An unused function code or a function code out of range was received. When the data read/written (except the first one) containing an unused function code. - In function reading Zero (0) will be read, which will not result in an error. - In serial function writing The writing will be ignored, which will not result in an error.
		Improper number of data	- When the number of data read/written is not between 1 and 50. - No error will result when the value of the function code plus the number of data is beyond the setting range of the function code.
		Diagnosis code error (maintenance code)	A value other than 0 was received although the diagnosis code as the maintenance code was fixed to 0.
3	Improper data	Data range error	The data written is beyond the permissible write range.
7	NAK	No right of writing	This error does not occur in the FRENIC-Mini.
		Write disable	- Writing was attempted to the functions to which writing from RTU is prohibited or to which writing is disabled during operation. - Writing was attempted to a function code (other than S01, S05, S06, S13, and S14) that could not be written when the voltage was insufficient.

- If response is sent back to an improper query, a subcode will be set in an error code (that can be referred to with M26).

3.1.5 Communications examples

Typical communications examples are shown below (the station address is 5 in all cases).

(Example 1) M06: The actual frequency and speed values will be read.

Query (host ⇒ inverter)

05	03	08	06	00	01	67	EF

Normal response (inverter ⇒ host)

05	03	01	27	10	A3	B8

The detected speed value is 2710_H, or 10000_d. The actual frequency is 30 Hz according to the expression shown below:

$$10000 \times \frac{\text{Maximum output frequency}}{20000} = 30\ (\text{Hz})$$ (Maximum output frequency: 60 Hz)

(Example 2) S01: The value of 15Hz will be written to speed setting 1 (maximum output frequency: 60 Hz).

According to the expression shown below, the value to be written is 1388_H.

$$15\text{Hz} \times \frac{20000}{60\ (\text{Hz})} = 5000_d = 1388_H$$

Query (host ⇒ inverter)

05	06	07	01	13	88	D5	AC

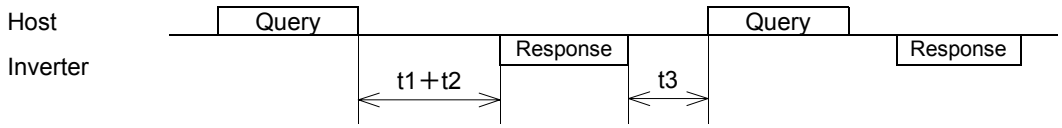
Normal response (inverter ⇒ host)

05	06	07	01	13	88	D5	AC

3.2 Host Side Procedures

3.2.1 Inverter's response time

Upon receipt of a query from the host, the inverter executes the queried transaction and sends back response after the response time shown below:



t1 + t2: Inverter's response time

t1: Response interval time (function code: y09)
The time until the inverter starts to send response to the query from the host controller, such as a personal computer, can be set. Setting the response interval time enables even a host controller with a slow transaction execution speed to adjust timing.

t2: Inverter's transaction time
This is the time until the inverter executes the query and sends back response as shown in Table 3.4.

t3: See "3.2.3 Receiving preparation complete time and message timing from the host."

Table 3.4 Inverter's transaction time

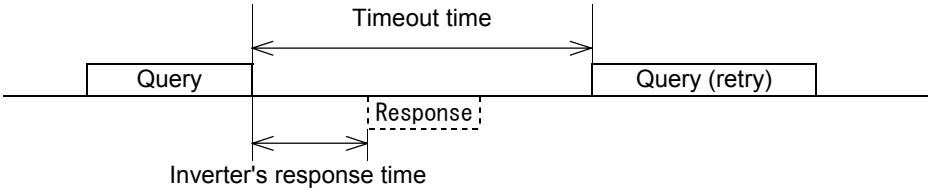
FC	Transaction	Description	t2	Timeout time (recommended)
3	Function code data reading	The number of data is three or less.	≤10ms	0.1s
		The number of data is four or more.	≤30ms	0.1s
6	Single function code data writing	S01, S05, S06, S13, S14: Command	≤10ms	0.1s
		Other than S01, S05, S06, S13, S14, and H03	≤100ms	0.5s
		H03 = 2: Motor parameter initialization	≤500ms	1.0s
		H03 = 1: Data initialization	≤5s	10.0s
8	Maintenance code		≤10ms	0.1s
16	Serial function code data writing	The function code data writing time is two seconds in the case of wiring 50 serial words.	≤2s	10.0s

3.2.2 Timeout processing

To read/write data from/to the host, transmit the next frame after confirming response. If response is not transmitted from the inverter for more than a specified period of time (timeout time), it is a timeout, and perform a retry. (If a retry begins before a timeout time elapses, the requested frame cannot be received properly.)

The timeout time must be set longer than the response time of the inverter. Table 3.4 above shows recommended timeout times when no response interval time is set.

In case of a timeout, retransmit the same frame or read details of the error (M26) to confirm whether the inverter sends back normal response. If normal response is returned, this indicates that some transient transmission error occurred due to noise or for other reasons, and subsequent communications is normal. (However, if this phenomenon frequently occurs even when normal response is sent back, some problem may exist. Perform a close investigation.) In case of no response, perform another retry. If the number of retries exceeds the set value (generally about three times), there may be a problem with the hardware and the software for the high-order appliance. Investigate and correct the cause.



3.2.3 Receiving preparation complete time and message timing from the host

The time from the return of response by the inverter until the completion of receiving preparation of the communications port (switching from transmission to receiving) is called a receiving preparation complete time.

Transmit the following messages after the receiving preparation complete time:

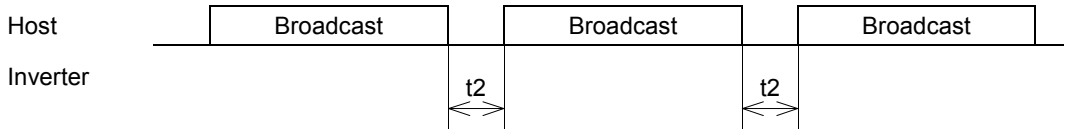
Receiving preparation complete time: 5 ms or less

Receiving waiting time from the host (t3): t3 > 5 ms

In the case of broadcast

Upon receipt of a query message from the host by broadcast, the inverter executes the query and enters the receiving enabled status.

Transmit the next message from the host after broadcast after the transaction time (t2) of the inverter.

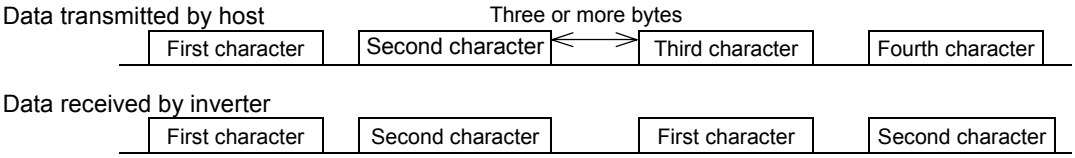


3.2.4 Frame synchronization method

Since the RTU transmits and receives binary data without using header characters for frame synchronization, a frame synchronization system is defined as a time without data to identify the head of the frame.

If data communications does not occur for a period equal to three bytes (33 bits including the start and stop bits) at the current transmission speed during receiving standby, initialize the frame information, and consider the first received data the first byte of the frame. Any frame being received before the time without data for three bytes will be discarded.

For this reason, the host must transmit data at a time interval of three or less bytes between two characters.



With regard to data to another station, messages from the host and response from that station will be received. In response transmission to identify the head of the frame, a waiting time of three bytes (33 bits including the start and stop bits) is required between the completion of data receipt by the station and the start of transmission. Any devices multi-dropped also requires such a waiting time.

3.3 Communications Errors

3.3.1 Categories of communications errors

The communications-related errors the inverter detects are listed below:

Table 3.5 Communications errors detected by inverter

Error category	Error name	Description	Error code (M26)
Logical error	Improper FC	See "Table 3.3 Subcodes" shown in 3.1.4 [5].	1(01_H)
	Improper address		2(02_H)
	Improper data		3(03_H)
	NAK		7(07_H)
Transmission error	CRC error	The frame to the local station is found unmatched in CRC collation.	71(47_H)
	Parity error	The parity is unmatched.	72(48_H)
	Other errors	Receiving errors other than the abovementioned (framing error, overrun error)	73(49_H)
Communica-tions disconnection error	Communications disconnection error	The inverter did not receive a normal frame addressed to local or to other stations within the communications disconnection time set with the function code.	—

Logical error (error codes 1 to 7)

When a logical error is detected, an error response frame reports it. For further information, see "3.1.4 [5] Error response."

Transmission error (error codes 71 to 73)

When a transmission error occurs eight straight times, it is handled as a communications error. However, the inverter does not return response in order to avoid overlapping of response from multiple inverters. The count of eight straight times will be cleared upon normal receipt of a frame to another station or to the local inverter (station) itself.

Communications disconnection error

If the inverter in operation does not receive a normal frame to itself or to other stations when it has received a normal frame more than once and is operating via communications (frequency command or operation command), this status is considered disconnected.
When a disconnection status is set and remains over the setting of function code y08 (communications disconnection detection time), it is treated as a communications error.

1) Communications disconnection detection time (y08): 0 (without detection), 1 to 60 (seconds)

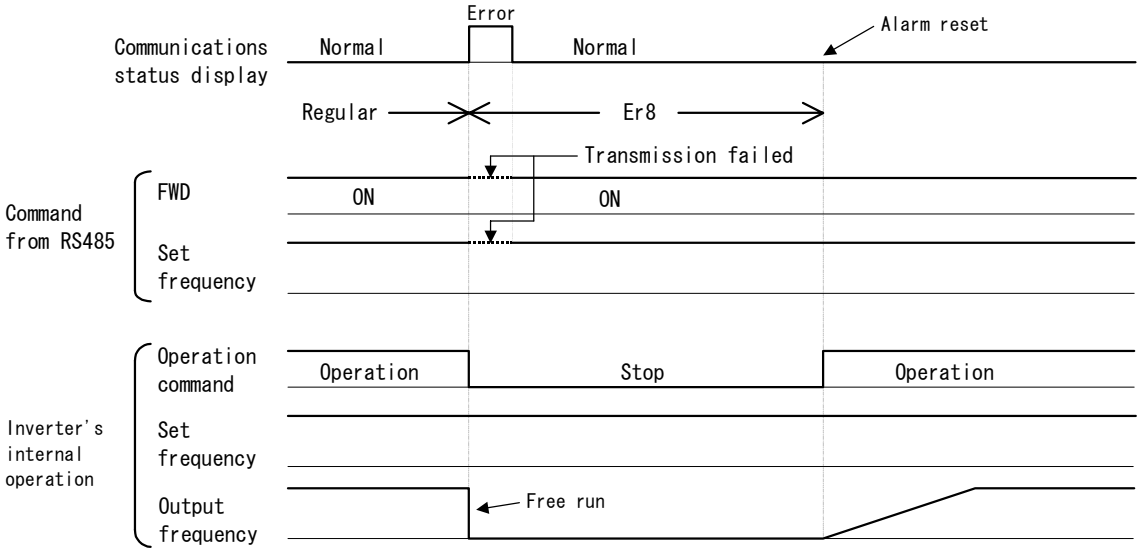
2) Condition to clear communications disconnection detection timer:
It will be cleared in a status other than disconnection.

When it is necessary to take action against errors by factor, the factor can be identified by reading M26. (M26 stores the latest communications error codes.)

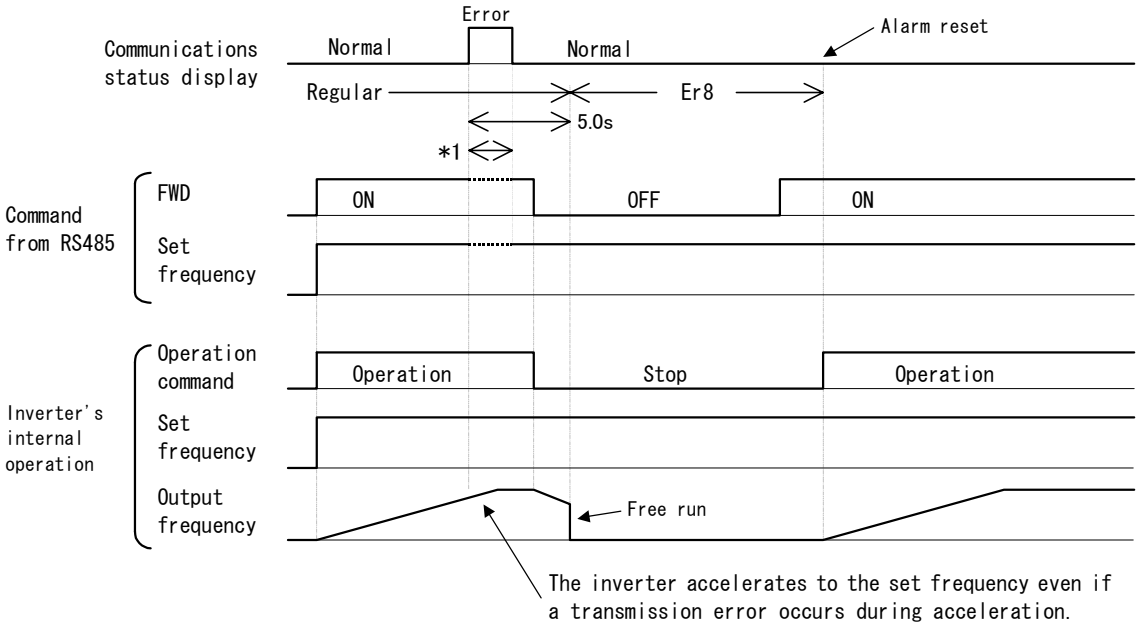
3.3.2 Operations in case of errors

The action when a transmission or communications disconnection error occurs can be selected with function code y02. (For further information, see "2.4 Making RS485-related settings.")
This section shows specific examples of action by different settings of function code y02.

When y02 = 0 (mode in which the inverter is forced to immediately stop in case of communications error)



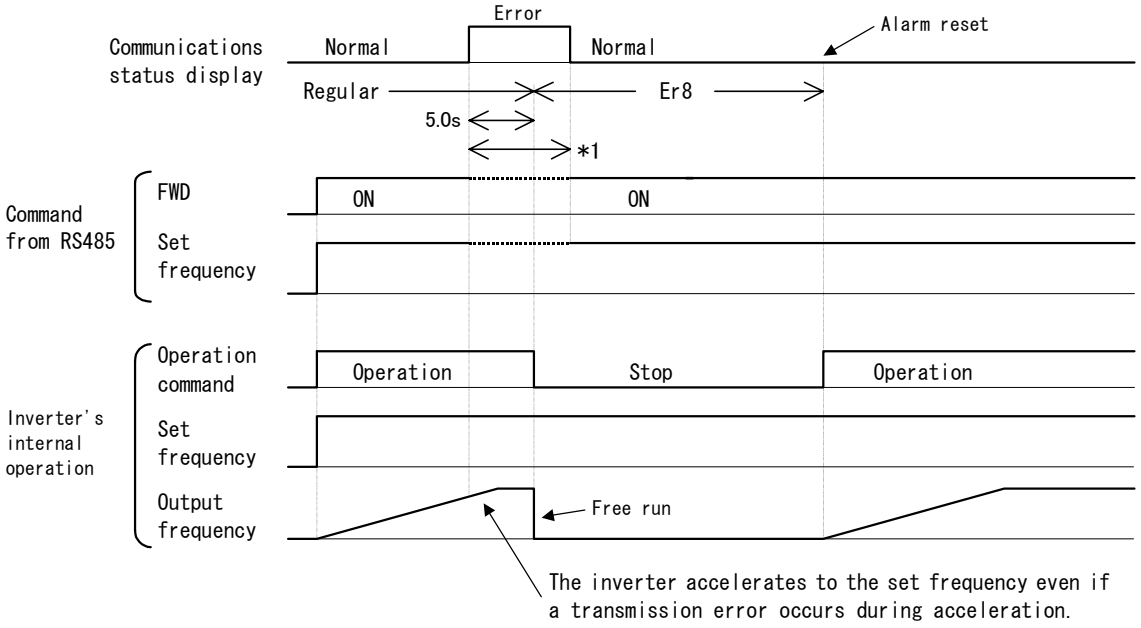
When y02 = 1 and y03 = 5.0 (seconds) (mode in which the inverter is forced to stop five seconds after a communications error occurred)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 2 and y03 = 5.0 (seconds)

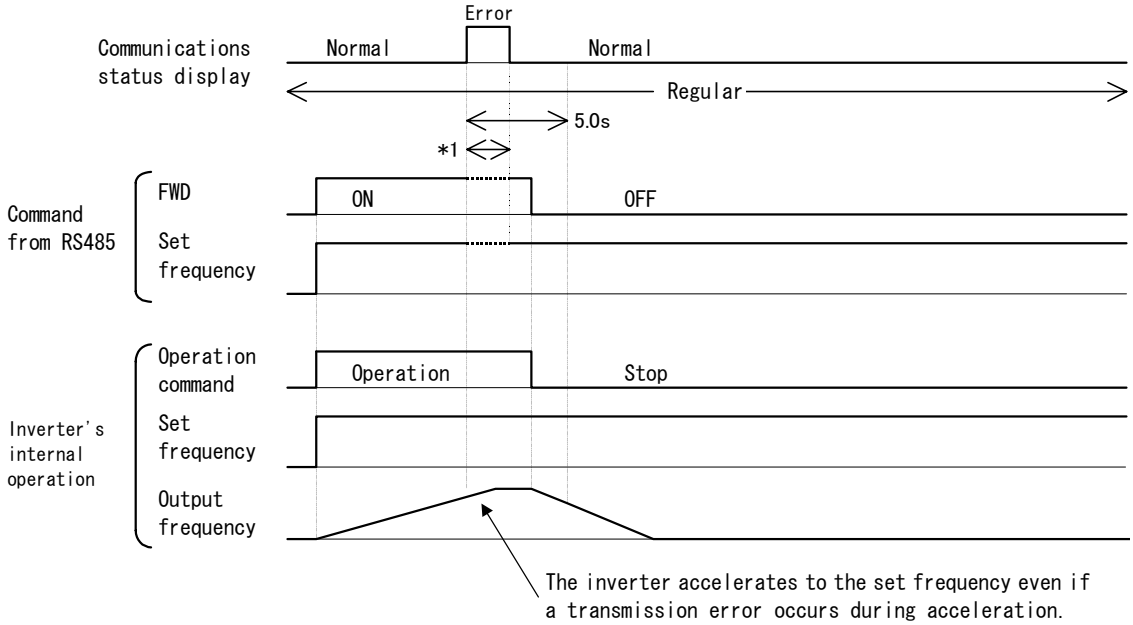
(when communications is not recovered although five seconds elapsed from the occurrence of a communications error, and an *Er8* trip occurs)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 2 and y03 = 5.0 (seconds)

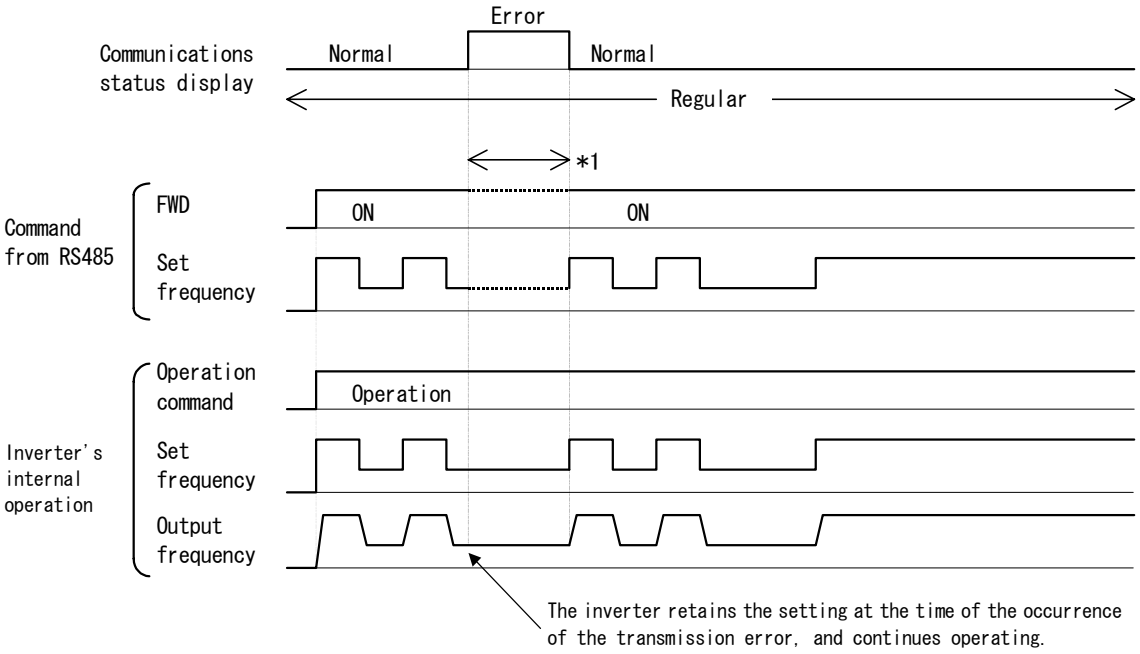
(when a communications error occurred but communications was recovered within five seconds)



*1 For the period until communications is recovered, the command (command data, operation data) executed just before the communications error had occurred is retained.

When y02 = 3

(mode in which the inverter continues operating when a communications error occurs)



3.4 CRC-16

3.4.1 Overview of the CRC-16

The CRC (cyclic redundancy check) is a system to confirm whether there is any error in the communications frame during data transmission.
The CRC is among the most effective error check systems. The transmission station calculates and adds CRC data to the last block of the frame, and the receiving station also calculates CRC data against the data received, and compares them with each other.

Steps to calculate CRC data

- Polynomial data (for example, 1100 0000 0010 0001 $\rightarrow X^{15} + X^{14} + X^5 + 1$) is divided by a generative polynomial expression (17 bits: $X^{16} + X^{15} + X^2 + 1$). CRC data is the remainder (16 bits) of this division.
- The quotient is ignored, and a message is transmitted with the remainder added to the last block of the data.
- The receiving station divides this message (with the CRC added) by the generative polynomial expression, and considers the transmitted message to have been received without any error if the "remainder" is 0.

CRC-16

The generative polynomial expression is expressed as a multiplier of X, such as $X^3 + X^2 + 1$, in place of the description of binary code 1101. Although any prime polynomial expression is acceptable as the generative polynomial expression, some standard generative polynomial expressions for optimizing error detection are defined and proposed. The RTU protocol uses the generative polynomial expression ($X^{16} + X^{15} + X^2 + 1$) corresponding to binary code 1 (1000 0000 0000 0101). In this case, the CRC generated is well known as CRC-16.

3.4.2 Algorithm

Figure 3.1 on the following page shows the algorithm for calculating CRC-16. Consult it together with the calculation example that follows.

In this figure, the transmission station calculates CRC data and finally adds it to the transmission frame as a check code.

The receiving station uses the same algorithm to perform a transaction. However, it collates the CRC data it calculated with the transmitted CRC data.

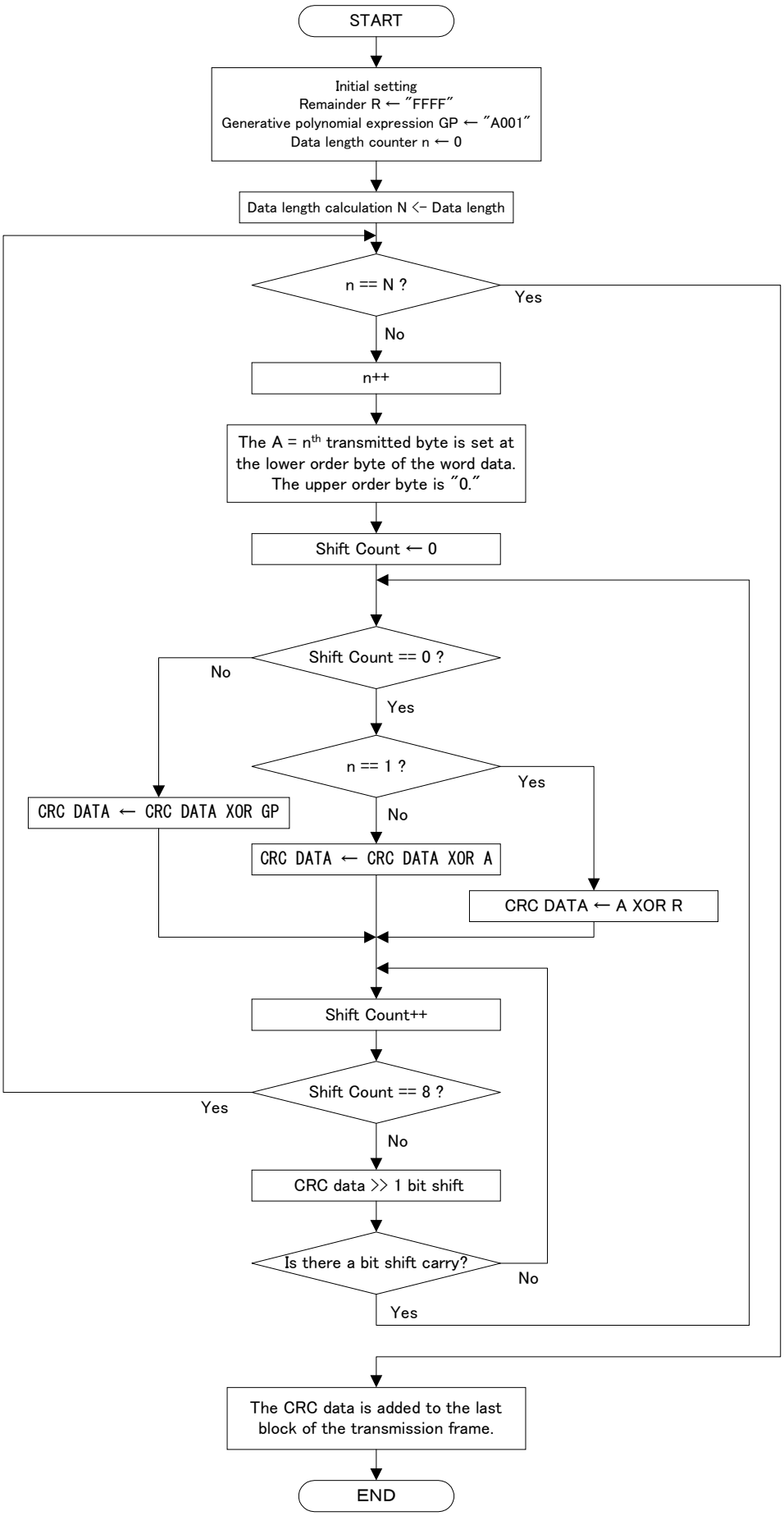

START
Initial setting
Remainder R ← "FFFF"
Generative polynomial expression GP ← "A001"
Data length counter n ← 0
Data length calculation N <- Data length
n == N ?
Yes
No
n++
The A = nth transmitted byte is set at the lower order byte of the word data. The upper order byte is "0."
Shift Count ← 0
Shift Count == 0 ?
No
Yes
n == 1 ?
Yes
No
CRC DATA ← CRC DATA XOR GP
CRC DATA ← CRC DATA XOR A
CRC DATA ← A XOR R
Shift Count++
Shift Count == 8 ?
Yes
No
CRC data >> 1 bit shift
Is there a bit shift carry?
No
Yes
The CRC data is added to the last block of the transmission frame.
END

Figure 3.11　CRC algorithm

3.4.3 Calculation example

Example of transmitting data read

Station address = 1, FC = 3, function code = P02 (P = 03_H, 02 = 02_H), number of data read = 20, GP = generative polynomial expression(1010 0000 0000 0001)

Station address	FC	Function code		Number of data read	
01_H	03_H	03_H	02_H	00_H	14_H

Table 3.6 CRC data calculation table

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
1	Initial data R = "FFFF"	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	1st data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	CRC = No.1 Xor No.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
4	Shift >> 2 (up to flag = 1)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CRC = No.4 Xor GP	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
6	Shift >> 2	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7	CRC = No.6 Xor GP	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
8	Shift >> 2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
9	CRC = No.8 Xor GP	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift >> 2 (shift of No. 8 terminated)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC = No.10 Xor GP	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
12	2nd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13	CRC = No.11 Xor No.12	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
14	Shift >> 1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
15	CRC = No.14 Xor GP	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
16	Shift >> 1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
17	CRC = No.16 Xor GP	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
18	Shift >> 2	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
19	CRC = No.18 Xor GP	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
20	Shift >> 2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1
21	CRC = No.20 Xor GP	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift >> 2 (shift of No. 8 terminated)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
23	3rd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
24	CRC = No.22 Xor No.23	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	
25	Shift >> 1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
26	CRC = No.25 Xor GP	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	
27	Shift >> 6	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
28	CRC = No.27 Xor GP	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	
29	Shift >> 1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1
30	CRC = No.29 Xor GP	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	
31	4th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
32	CRC = No.30 Xor No.31	1	1	1	1	0	0	0	1	0	1	1	0	0	0	1	0	
33	Shift >>2	0	0	1	1	1	1	0	0	0	1	0	1	1	0	0	0	1
34	CRC = No.33 Xor GP	1	0	0	1	1	1	0	0	0	1	0	1	1	0	0	1	
35	Shift >> 1	0	1	0	0	1	1	1	0	0	0	1	0	1	1	0	0	1
36	CRC = No.35 Xor GP	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1	
37	Shift >> 1	0	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1

(To be continued)

Table 3.6 CRC data calculation table (continued)

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
38	CRC = No.37 Xor GP	1	1	0	1	0	1	1	1	0	0	0	1	0	1	1	1	
39	Shift >> 1	0	1	1	0	1	0	1	1	1	0	0	0	1	0	1	1	1
40	CRC = No.39 Xor GP	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1	0	
41	Shift >>2	0	0	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1
42	CRC = No.41 Xor GP	1	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1	
43	Shift >> 1	0	1	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1
44	CRC = No.43 Xor GP	1	1	1	0	1	0	0	1	0	1	1	1	0	0	0	0	
45	5th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	CRC = No.44 Xor No.45	1	1	1	0	1	0	0	1	0	1	1	1	0	0	0	0	
47	Shift >> 5	0	0	0	0	0	1	1	1	0	1	0	0	1	0	1	1	1
48	CRC = No.47 Xor GP	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1	0	
49	Shift >> 2	0	0	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1
50	CRC = No.49 Xor GP	1	0	0	0	1	0	0	1	1	1	0	1	0	0	1	1	
51	Shift >> 1	0	1	0	0	0	1	0	0	1	1	1	0	1	0	0	1	1
52	CRC = No.51 Xor GP	1	1	1	0	0	1	0	0	1	1	1	0	1	0	0	0	
53	6th data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
54	CRC = No.52 Xor No.53	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	
55	Shift >> 3	0	0	0	1	1	1	0	0	1	0	0	1	1	1	1	1	1
56	CRC = No.55 Xor GP	1	0	1	1	1	1	0	0	1	0	0	1	1	1	1	0	
57	Shift >> 2	0	0	1	0	1	1	1	1	0	0	1	0	0	1	1	1	1
58	CRC = No.57 Xor GP	1	0	0	0	1	1	1	1	0	0	1	0	0	1	1	0	
59	Shift >> 2	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	1	1
60	CRC = No.59 Xor GP	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	
61	Shift >> 1 (shift of No. 8 terminated)	0	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0
	Transmitted CRC data	*4*				*1*				*E*				*4*				

From the above calculation, the transmitted data is as shown below:

Station address	FC	Function code		Number of data read		CRC check	
01_H	03_H	03_H	02_H	00_H	14_H	41_H	$E4_H$

3.4.4 Frame length calculation

To calculate CRC-16, it is necessary to know the length of variable length messages. The length of all types of messages can be determined according to Table 3.7 Lengths of response messages.

Table 3.7 Length of response messages

FC	Description	Query/Broadcast message length (except CRC code)	Length of response message (except CRC code)
3	Function reading	6 bytes	3 + (3rd) bytes*
6	Single function writing	6 bytes	6 bytes
8	Maintenance code	6 bytes	6 bytes
16	Serial function writing	7 + (7th) bytes*	6 bytes
128 to 255	Exception function	Unused	3 bytes

* 7th, 3rd: The 7th and 3rd byte count values stored in the frame.

CHAPTER 4

FUJI GENERAL-PURPOSE INVERTER PROTOCOL

This chapter describes the Fuji general-purpose inverter protocol, a common protocol to Fuji general-purpose inverters, as well as the host side procedure to use this protocol and error processing.

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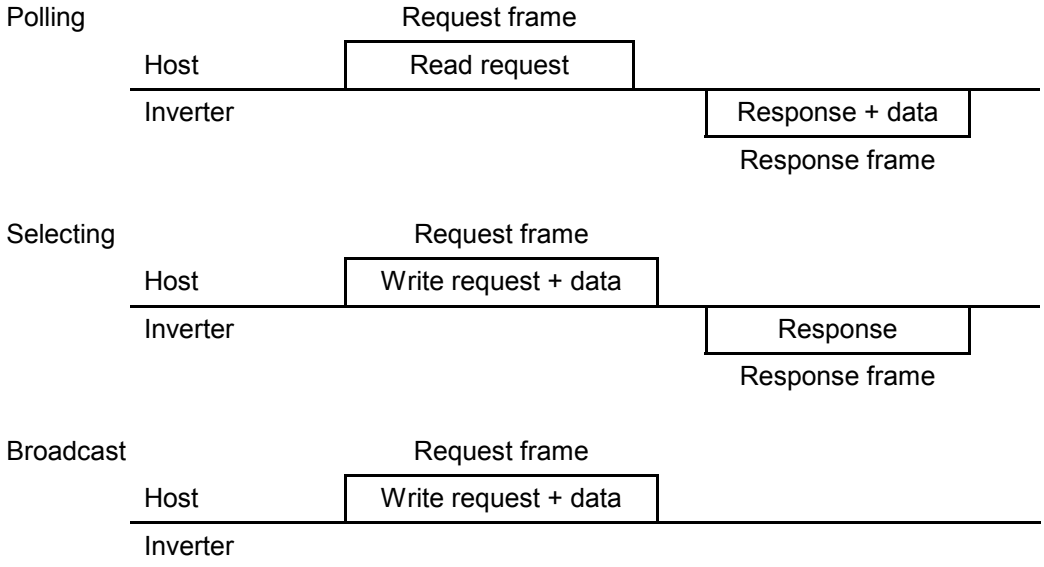
4.1 Messages

4.1.1 Message formats

The polling/selecting system is used to transmit and receive messages. The inverter always waits for selecting (write requests) or polling (read requests) from the host (personal computer, PLC).
When the inverter in the standby status receives a request frame from the host addressed to itself (local station) and considers the request frame to have been normally received, the inverter executes the transaction in response to the request, and sends back an acknowledgement (ACK) frame (or response and data in the case of polling). If the inverter judges that the receiving failed, it returns negative acknowledgment (NAK) frame. In the case of broadcast (all station batch selecting), the inverter does not send back response.

(Each frame is described in "4.1.2 Transmission frames.")



Broadcast (all station batch selecting)

A frame with the station address set to 99 is treated by all inverters as broadcast.
By using broadcast, operation or frequency commands can be simultaneously assigned to all inverters.
In broadcast communications, only selecting of S01, S05, S06, S13, and S14 in the standard frame, and commands (W, E, a, e, f, and m) in the optional frame are valid.

4.1.2 Transmission frames

Transmission frames are classified into two types; standard fames with which all communications functions are available, and optional frames, allowing high-speed communications, but whose function is limited to issuing commands to and monitoring the inverter.

All characters (including BCC) comprising both standard and optional frames are represented by ASCII codes. The lengths of standard and optional frames are as shown in Table 4.1 below:

Table 4.1 Lengths of transmission frames

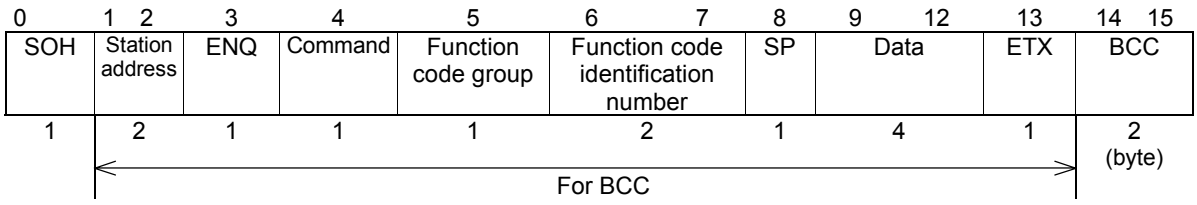
Frame type			Frame length
Standard frame	Selecting	Request	16 bytes
		Response	16 bytes
	Polling	Request	16 bytes
		Response	16 bytes
Optional frame	Selecting	Request	12 bytes
		Response	8 bytes
	Polling	Request	8 bytes
		Response	12 bytes

[1] Standard frame

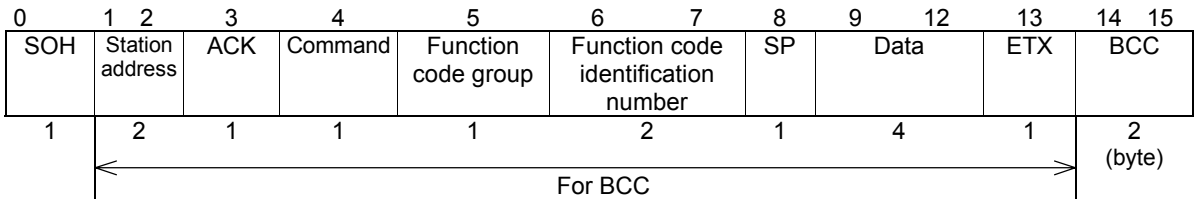
Standard frames are classified into request frame, ACK frame, and NAK frame, and their frame configurations are as shown below.

For the meanings of the fields comprising each frame, see the tables shown on the pages that follow.

Request frame [host ⇒ inverter]



ACK frame [inverter ⇒ host]



NAK frame [inverter ⇒ host]

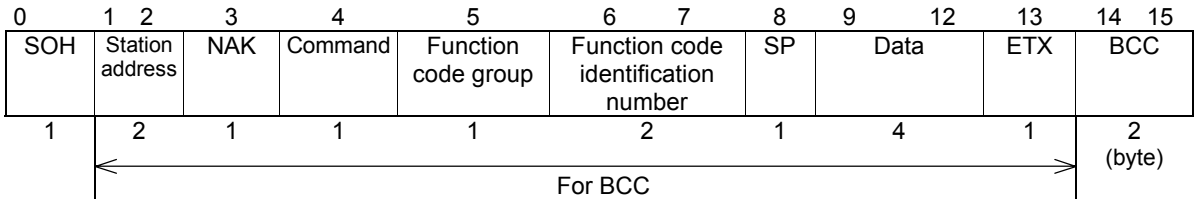


Table 4.2 Request frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3, 9	30_H to 33_H 39_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command	R W A E	52_H 57_H 41_H 45_H	Request command Polling (read) Selecting (write) High-speed response selecting (write) *2 Alarm reset
5	Function code group *1	F E C P H J Y S M W X Z	46_H 45_H 43_H 50_H 48_H $4A_H$ 59_H 53_H $4D_H$ 57_H 58_H $5A_H$	Function code group *3 Fundamental function Extension terminal function Control function of frequency Motor parameter High performance function Application function Link function Command data Monitor data 1 Monitor data 2 Alarm data 1 Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP	20_H	Unused (space fixed)
9	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
10		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
11		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for an alarm reset command.

*2 Use high-speed response selecting to read the monitor when a command, which takes time for selecting (see Table 4.12 in "4.2 Host Side Procedures"), is written. The inverter does not respond to the regular write command W until writing is completed. With regard to high-speed response command A, the inverter sends back response upon receipt of a write request and communications can, therefore, continue even during writing. To confirm whether writing is completed in this case, read the BUSY flag (M14: 15 bits). If additional writing is performed during writing, NAK (error during writing) will result.

*3 Function codes are divided into function codes that can be edited from the keypad of the inverter, and communications dedicated function codes.

Function codes editable from the keypad include fundamental function: F code, extension terminal function: E code, control function of frequency: C code, motor parameter: P code, high performance function: H code, application function: J code, and link function: y code. For further information about these codes, see "2.4 Making RS485-related settings" in Chapter 2 of this manual, and "Chapter 9 Function Codes" of the FRENIC-Mini User's Manual.

Communications dedicated function codes include command data: S code, monitor data 1: M code, monitor data 2: W code, alarm data 1: X code, and alarm data 2: Z code. For further information about these codes, see Chapter 5 Function Codes and Data Formats."

Table 4.3 ACK frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK	ACK	06_H	Transmission response Acknowledgement: There was no receiving or logical error.
4	Command	 R W A E	 52_H 57_H 41_H 45_H	Answerback of request command Polling (read) Selecting (write) High-speed response selecting (write) Alarm reset
5	Function code group *1	 F E C P H J Y S M W X Z	 46_H 45_H 43_H 50_H 48_H $4A_H$ 59_H 53_H $4D_H$ 57_H 58_H $5A_H$	Function code group Fundamental function Extension terminal function Control function of frequency Motor parameter High performance function Application function Link function Command data Monitor data 1 Monitor data 2 Alarm data 1 Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP	20_H	Unused (space fixed)
9	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
10		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
11		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for an alarm reset command.

Table 4.4 NAK frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	NAK	NAK	15_H	Transmission response Negative acknowledgement: There was a logical error in the request.
4	Command *1			Answerback of request command
		R	52_H	Polling (read)
		W	57_H	Selecting (write)
		A	41_H	High-speed response selecting (write)
		E	45_H	Alarm reset
5	Function code group *1			Function code group
		F	46_H	Fundamental function
		E	45_H	Extension terminal function
		C	43_H	Control function of frequency
		P	50_H	Motor parameter
		H	48_H	High performance function
		J	$4A_H$	Application function
		Y	59_H	Link function
		S	53_H	Command data
		M	$4D_H$	Monitor data 1
		W	57_H	Monitor data 2
		X	58_H	Alarm data 1
		Z	$5A_H$	Alarm data 2
6	Function code identification number *1	0 to 9	30_H to 39_H	Function code identification number (decimal: ten's figure)
7		0 to 9	30_H to 39_H	Function code identification number (decimal: one's figure)
8	Special additional data	SP	20_H	Unused (space fixed)
9	Data	SP	20_H	Unused (space fixed)
10		SP	20_H	Unused (space fixed)
11		0 to F	30_H to $3F_H$	Communications error code higher order (hexadecimal: ten's figure)
12		0 to F	30_H to $3F_H$	Communications error code lower order (hexadecimal: one's figure)
13	ETX	ETX	03_H	End of message
14	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
15		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

*1 A space (SP = 20_H) will be set for a transmission format or transmission command error.

[2] Optional frame

This section describes the structure and meaning of each optional frame.

Selecting request frame [host ⇒ inverter]

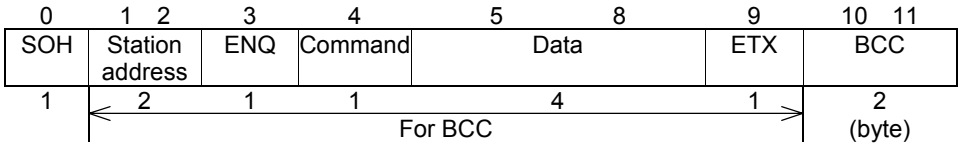


Table 4.5 Selecting request frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3, 9	30_H to 33_H 39_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command			Request command
		a	61_H	Speed setting (S01)
		e	65_H	Frequency command (S05)
		f	66_H	Operation command (S06)
		m	$6D_H$	Reset command: All "0"
5	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
6		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
7		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
8		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
9	ETX	ETX	03_H	End of message
10	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
11		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Selecting response frame [inverter ⇒ host]

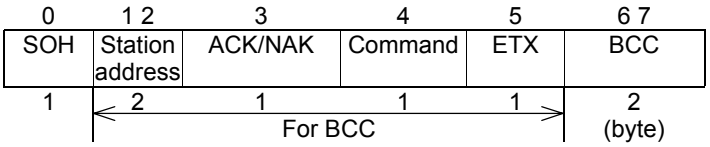


Table 4.6 Selecting response frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK/NAK	ACK	06_H	Transmission response Acknowledgement: There was no receiving or logical error.
		NAK	15_H	Negative acknowledgment: There was a logical error in the request.
4	Command			Request command
		a	61_H	Speed setting (S01)
		e	65_H	Frequency command (S05)
		f	66_H	Operation command (S06)
		m	$6D_H$	Reset command: All "0"
5	ETX	ETX	03_H	End of message
6	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
7		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Polling request frame [host ⇒ inverter]

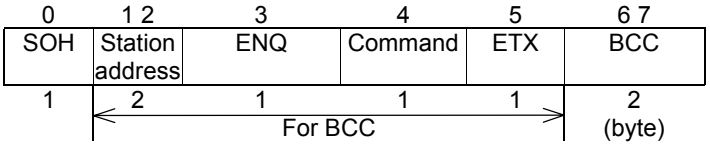


Table 4.7 Polling request frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ENQ	ENQ	05_H	Transmission request
4	Command			Request command
		g	67_H	Actual frequency, actual speed (S06)
		j	$6A_H$	Output frequency monitor (S09)
		k	$6B_H$	Operation status monitor (M14)
5	ETX	ETX	03_H	End of message
6	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
7		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

Polling response frame [inverter ⇒ host]

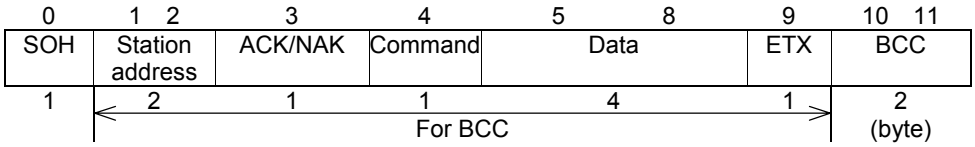


Table 4.8 Polling response frame

Byte	Field	Value		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Start of message
1	Station address	0 to 3	30_H to 33_H	Station address of the inverter (decimal: ten's figure)
2		0 to 9	30_H to 39_H	Station address of the inverter (decimal: one's figure)
3	ACK/NAK	ACK NAK	06_H 15_H	Transmission request Acknowledgement: There was no receiving or logical error. Negative acknowledgment: There was a logical error in the request.
4	Command	g j k	67_H $6A_H$ $6B_H$	Request command Actual frequency, actual speed (S06) Output frequency monitor (S09) Operation status monitor (M14)
5	Data	0 to F	30_H to $3F_H$	Data's first character (hexadecimal: thousand's figure)
6		0 to F	30_H to $3F_H$	Data's second character (hexadecimal: hundred's figure)
7		0 to F	30_H to $3F_H$	Data's third character (hexadecimal: ten's figure)
8		0 to F	30_H to $3F_H$	Data's fourth character (hexadecimal: one's figure)
9	ETX	ETX	03_H	End of message
10	BCC	0 to F	30_H to $3F_H$	Checksum 1 (hexadecimal: ten's figure)
11		0 to F	30_H to $3F_H$	Checksum 2 (hexadecimal: one's figure)

[3] NAK frame

When the response frame length is determined by the command type and the command type character is correctly identified, response will be given according to the frame length specified by the command in principle.

Table 4.9 Negative acknowledgment (NAK) frame

No.	Frame/ Command type	Cause of error	NAK response frame	Error code (M26)
1	Standard frame Optional frame	The ENQ was not detected in the specified position.	Standard fame (16 bytes long)	Format error [74]
2	Selecting command (a, e, f, m)	The ETX was not detected in the specified position.	Optional frame (8 bytes long)	Format error [74]
3	Polling command (g, j, k)	The ETX was not detected in the specified position.	Optional frame (12 bytes long)	Format error [74]
4	Other than specified commands	A command other than the specified commands (R, W, A, E, a, e, f, g, j, k, m) was detected.	Standard frame (16 bytes long)	Command error [75]

CAUTION When negative acknowledgement (NAK) for a format or command error is returned with the standard format as in the case of No. 1 and No. 4, the contents of the command type, function code group, and function code identification number fields will be undefined.

4.1.3 Descriptions of fields

[1] Command field

The table below shows command types. The applicable frame is different among the command types.

Table 4.10 Command formats

Command	Description	Applicable frame
ASCII R	Reads function code data (polling).	Standard frame
ASCII W	Writes function code data (selecting).	
ASCII A	Writes function code data at high speed (writing that does not wait for writing to be completed).	
ASCII E	Resets an alarm.	
ASCII a	Gives a frequency command (S01). *1	Optional frame
ASCII e	Gives a frequency command (S05). *1	
ASCII f	Gives an operation command (S06). *1	
ASCII g	Reads the output frequency (M06). *1	
ASCII j	Reads the output frequency (M09). *1	
ASCII k	Reads the operation status monitor (M14). *1	
ASCII m	Resets an alarm.	

*1 The above commands “a” to “k” are used to read or write data in the function code data format specified in parentheses.

[2] Data field

Standard frame

8	9	10	11	12
Special additional data	Data's first character	Data's second character	Data's third character	Data's fourth character

Optional frame

9	10	11	12
Data's first character	Data's second character	Data's third character	Data's fourth character

All data, except for some special ones, are treated as 16 bits long. In the data field of the communications frame, data is hexadecimal (0000_H - $FFFF_H$), and each digit is represented by an ASCII code. Negative integer data (signed data) is treated as a complement of 2 of the integer data without the sign.

CAUTION
- The alphabetic characters A to F of hexadecimal data must be uppercase.
- Set 0 in all the data fields of the request frame for polling.
- In selecting, the data field of the ACK frame will be undefined.

(Example) When setting 20Hz with function code S01 (speed setting 1) (maximum output frequency = 60Hz)

1)Calculate the set value according to the data format of S01 (±20,000/maximum output frequency).

Data = 20Hz x ±20,000/60Hz (+ for forward rotation, - for reverse rotation)

=±6666.6

≈±6667

2) Convert the data into hexadecimal (a complement of 2 in the case of negative data).

Data = 6667 ..... (forward rotation)

$=1A0B_H$

Data = -6667 ..... (reverse rotation)

= 0 - 6667

Thus,

65536 - 6667 = 58869 = $E5F5_H$

3) Set the data.

Position	Set value (forward rotation)	Set value (reverse rotation)
Data's first character	ASCII 1	ASCII E
Data's second character	ASCII A	ASCII 5
Data's third character	ASCII 0	ASCII F
Data's fourth character	ASCII B	ASCII 5

[3] Checksum field

The data in this field is intended to check whether there is any error in the communications frame at the time of data transmission. Calculate the data by adding one byte to all fields, except for S0H and the checksum field, treating the last byte of the result as a two-digit hexadecimal value, and converting each digit into an ASCII code.

(Example) When the result of addition is 0123_H

Position	Set value (forward rotation)
Checksum 1	ASCII 2
Checksum 2	ASCII 3

4.1.4 Communications examples

Typical communications examples are shown below (the station number is 12 in all cases):

[1] Standard frame

(Example 1) Selecting S01: speed setting 1 (write)

10Hz command x 20,000/maximum output frequency 50Hz = 4000d = $0FA0_H$

Request frame (host ⇒ inverter)

SOH	1	2	ENQ	W	S	0	1	SP	0	F	A	0	ETX	7	D

ACK frame (inverter ⇒ host)

SOH	1	2	ACK	W	S	0	1	SP	0	F	A	0	ETX	7	E

NAK frame (inverter ⇒ host) ... Link priority error

SOH	1	2	NAK	W	S	0	1	SP	SP	4	C	0	ETX	8	D

(Example 2) Polling of M09: output frequency (read)

Request frame (host ⇒ inverter)

SOH	1	2	ENQ	R	M	0	9	SP	0	0	0	0	ETX	5	3

ACK frame (inverter ⇒ host)

SOH	1	2	ACK	R	M	0	9	SP	0	B	B	8	ETX	8	0

[2] Optional frame

(Example 1) Selecting of operation command (write)

Request frame (host ⇒ inverter) ... FWD command

SOH	1	2	ENQ	f	0	0	0	1	ETX	9	2

ACK frame (inverter ⇒ host)

SOH	1	2	ACK	f	ETX	D	2

NAK frame (inverter ⇒ host)

The cause of the error can be confirmed with function code M26 (transmission error transaction code).

SOH	1	2	NAK	f	ETX	E	1

(Example 2) Selecting of operation command in broadcast (write)

Request frame (host ⇒ inverter) ... REV command

SOH	9	9	ENQ	f	0	0	0	2	ETX	A	2

The inverter does not respond to broadcast.

Table 4.11 ASCII code table

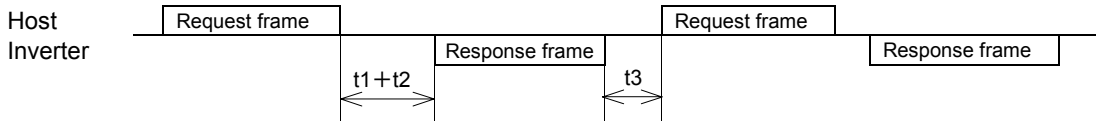
	00_H	10_H	20_H	30_H	40_H	50_H	60_H	70_H
0_H	NUL	DLE	SP	0	@	P	`	p
1_H	SOH	DC1	!	1	A	Q	a	q
2_H	STX	DC2	“	2	B	R	b	r
3_H	ETX	DC3	#	3	C	S	c	s
4_H	EOT	DC4	$	4	D	T	d	t
5_H	ENQ	NAK	%	5	E	U	e	u
6_H	ACK	SYN	&	6	F	V	f	v
7_H	BEL	ETB	‘	7	G	W	g	w
8_H	BS	CAN	(	8	H	X	h	x
9_H	HT	EM	)	9	I	Y	i	y
A_H	LF	SUB	*	:	J	Z	j	z
B_H	VT	ESC	+	;	K	[	k	{
C_H	FF	FS	,	<	L	\	l	|
D_H	CR	GS	-	=	M	]	m	}
E_H	SO	RS	.	>	N	-	n	to
F_H	SI	US	/	?	O	_	o	DEL

The shaded codes are used for this communications protocol.

4.2 Host Side Procedures

4.2.1 Inverter's response time

Upon receipt of a query request from the host, the inverter executes the requested command, and sends back response after the response time shown below:



t1 + t2: Inverter's response time

t1: Response interval time (function code: y09)
The time until the inverter starts to send response to the request from the host controller, such as a personal computer, can be set. Setting the response interval time enables even a host controller with a slow transaction execution speed to adjust timing.

t2: Inverter's transaction time
This is the time until the inverter executes the request and sends back response as shown in Table 4.12 below.

t3: See "4.2.3 Receiving preparation complete time and message timing from the host."

Table 4.12 Inverter's transaction time

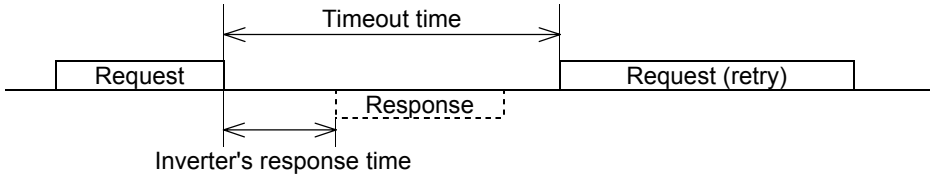
Command	Transaction	Description	t2	Timeout time (recommended)
R	Function code data reading		≤10ms	0.1 sec
W	Function code data writing	S01, S05, S06, S13, S14: Command	≤10ms	0.1 sec
		Other than S01, S05, S06, S13, S14, and H03	≤100ms	0.5 sec
		H03 = 2: Motor parameter initialization	≤500ms	1.0 sec
		H03 = 1: Data initialization	≤5s	10.0 sec
A	Function code data high-speed writing		≤10ms	0.1 sec
E, m	Alarm reset		≤10ms	0.1 sec
A, e, f	Specific function code data writing		≤10ms	0.1 sec
G, j, k	Specific function code data reading		≤10ms	0.1 sec

4.2.2 Timeout processing

To read/write data from/to the host, transmit the next frame after confirming response. If response is not transmitted from the inverter for more than a specified period of time (timeout time), it is a timeout, and perform a retry. (If a retry begins before a timeout, the requested frame cannot be received properly.)

The timeout time must be set longer than the response time of the inverter. Table 4.12 above mentioned shows recommended timeout times when no response interval time is set.

In case of a timeout, retransmit the same frame or perform polling (M26) for reading details of an error to confirm whether the inverter sends back normal response. If normal response is returned, this indicates that some transient transmission error occurred due to noise or other reasons, and subsequent communications is normal. (However, if this phenomenon frequently occurs even when normal response is sent back, some problem may exist. Perform a close investigation.) In case of no response, perform another retry. If the number of retries exceeds the set value (generally about three times), there may be a problem with the hardware and the software for the host controller. Investigate and correct the cause.



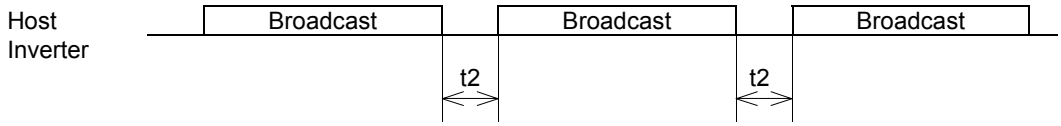
4.2.3 Receiving preparation complete time and message timing from the host

The time from the return of response by the inverter to the completion of receiving preparation of the communications port (switching from transmission to receiving) is called a receiving preparation complete time.
Transmit the following messages after the receiving preparation complete time:

Receiving preparation complete time: 5ms or less
Message timing from the host (t3): t3 > 5ms

In the case of broadcast

Upon receipt of a request for a query message from the host by broadcast, the inverter executes the command and enters the receiving enabled status.
Transmit the next message from the host following broadcast after the transaction time (t2) of the inverter.



4.3 Communications Errors

4.3.1 Categories of communications errors

The communications-related errors the inverter detects are listed below:

Table 4.13 Communications errors detected by inverter

Error category	Error name	Description	Error code (M26)
Transmission error	Checksum error	The frame to the local station is found unmatched in checksum collation.	71(47_H)
	Parity error	The parity is unmatched.	72(48_H)
	Other errors	Receiving errors other than the abovementioned (framing error, overrun error)	73(49_H)
Logical error	Format error	- The characters of the transmission request are incorrect. -The last character of the message is not in the specified position.	74($4A_H$)
	Command error	A command that does not exist was transmitted.	75($4B_H$)
	Link priority error	This error does not occur in the FRENIC-Mini.	76($4C_H$)
	Error of no right of function code data writing	This error does not occur in the FRENIC-Mini.	77($4D_H$)
	Function code error	A function code that does not exist was requested.	78($4E_H$)
	Write disabled error	- An attempt was made during operation to write the function code for write disabled or for write disabled during operation. - An attempt was made to write the function code for write disabled while the undervoltage occurs (other than S01, S05, S06, S13, S14, and y99).	79($4F_H$)
	Data error	The data written is beyond the writable range.	80(50_H)
	Error during writing	An attempt was made to write another function data during function writing with command A.	81(51_H)
Communi-cations disconnec-tion error	Communications disconnection error	The inverter did not receive a normal frame addressed to local station or to other stations within the communications disconnection detection time set with the function code.	-

Transmission error (error codes 71 to 73)

When a transmission error occurs eight straight times, it is handled as a communications error. However, the inverter does not return response in order to avoid overlapping of response from multiple inverters. The count of eight straight times will be cleared upon normal receipt of a frame to another station or to the local inverter (station) itself.

Logical error (error codes 74 to 81)

When a logical error is detected, a negative acknowledgment (NAK) frame reports it. For further information, see the NAK response of each frame.

Communications disconnection error

If the inverter in operation does not receive a normal frame to itself (local station) or to another station when it has received a normal frame more than once and is operating via communications (frequency command or operation command), this status is considered disconnected.
When a disconnection status is set and remains over the setting time of function code y08 (communications disconnection detection time), it is treated as a communications error.

1) Communications disconnection detection time (y08): 0 (without detection), 1 to 60 (seconds)
2) Condition to clear communications disconnection detection timer: It will be cleared in a status other than disconnection.

When it is necessary to take action against errors by factor, the factor can be identified by reading M26. (M26 stores the latest communications error codes.)

4.3.2 Operations in case of communications errors

Operations in case of a transmission or communications disconnection error are the same as those of the Modbus RTU protocol. See "3.3.2 Operations in case of errors" in Chapter 3 Modbus RTU Protocol.

CHAPTER 5 FUNCTION CODES AND DATA FORMATS

This chapter describes communications dedicated function codes and the data formats of communications frames.

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5.1 Communications Dedicated Function Codes

5.1.1 About communications dedicated function codes

Communications dedicated function codes are available to monitor the operation and status of the inverter via communications. They are classified into the groups shown in Table 5.1 below:

Table 5.1 Types of communications dedicated function codes

Communications dedicated function code group	Function
S	Command data
M	Monitor data (for reading only)
W	Monitor data out of keypad display information (for reading only)
X	Alarm information out of keypad display information (for reading only)
Z	

The sections that follow describe communications dedicated function codes of each group.

5.1.2 Command data

[1] Frequency and PID command data

Table 5.2 Function codes for frequency and PID command data

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W *
S01	Frequency command (p.u.)	Frequency command via communications (value based on the maximum output frequency)	-32768 to 32767 (±20,000 = maximum output frequency)	1	-	R/W
S05	Frequency command	Frequency command from communications (by 0.01Hz)	0.00 to 655.35	0.01	Hz	R/W
S13	PID command	PID command from communications	-32768 to 32767 (±100% at ±20,000)	1	-	R/W

* R: Readable; W: Writable; R/W: Readable/Writable

1) When both S01 and S05 are set and S01 is not 0, the command of S01 has precedence over that of S05.
2) The actual operation specified by each command is limited by internal processing of the inverter. For example, a value over 20,000 can be written to S01, but the actual frequency is limited to the maximum output frequency or to the upper limit frequency set with another function code. (The FRENIC-Mini treats negative data of S13 as 0.)
3) When an attempt is made to read the command data shown here, the data previously directed by communications, not the command value for actual operation, will be read. (Obtain the latest command value by reading the M code.)
4) At S01, set a value based on ±20,000 as the maximum output frequency. For example, when the maximum output frequency is 60Hz, set 20,000 at S01 with a set frequency of 60Hz, or 10,000 with a set frequency of 30Hz.

[2] Operation command data

Table 5.3 Function codes for operation command data

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W *
S06	Operation command	Operation command via communications (general-purpose input terminal functions (X1 - X3, XF (FWD), XR (REV)) and communications dedicated command (FWD, REV, RST)	0000_H to $FFFF_H$	1	-	R/W
S14	Alarm reset command	Alarm reset command via communications	0 or 1	1	-	R/W

* R: Readable; W: Writable; R/W: Readable/Writable

1) To make alarm resetting with S06, bit 15 must be set to 1 and then set back to 0. Alarm resetting is impossible unless the communications side is made valid by the settings of function codes H30 and y99 and the "LE" assigned terminal.
2) S14 does not require the operation described in 1) above, and writing 1 permits alarm resetting (because writing the value once turns ON the reset command that will be turned OFF after a specific period of time). This command is 0 whenever it is read, and is always valid, irrespective of function codes H30 and y99 and the status of the "LE" assigned terminal.
3) X1 - X3, XF (FWD), and XR (REV) operate according to the functions set with function codes E01 - E03, E98, and E99.
4) When giving operation command S06 via communications, the relation between S06 and the inverter terminal (external signal input) command is shown in Table 5.4 on the next page.

⚠ WARNING

If alarm resetting is performed with the operation command (S06) uncleared, the inverter will start to operate just upon alarm resetting. Before alarm resetting, confirm that the operation command is cleared.

Otherwise, an accident may result.

Table 5.4 Relation between operation command (S06) and inverter terminal command (external signal input)

Function				When not assigned (positive logic)	Command	
Type	Assign-ment number	Internal operation command symbol	Name		Com-munica-tions	Terminal block
Fixed function	-	FWD	Forward operation/stop command	-	Valid	Invalid
		REV	Reverse operation/stop command	-		
		RST	Alarm reset	-		
General-purpose input X1 X2 X3 XF (FWD) XR (REV)	0	SS1	Multistep frequency 1	OFF	Valid	Invalid
	1	SS2	Multistep frequency 2	OFF		
	2	SS4	Multistep frequency 4	OFF		
	4	RT1	Acceleration/Deceleration time selection	OFF		
	6	HLD	3-wire operation stop command	OFF	Invalid	
	7	BX	Coast-to-stop command	OFF	Valid	
	8	RST	Alarm reset	OFF		
	9	THR	Trip command (External fault)	ON	Invalid	Valid
	10	JOG	Jogging operation	OFF	Invalid	
	11	Hz2/Hz1	Frequency setting 2/1 switching command	OFF	Valid	Invalid
	19	WE-KP	Write enable for keypad	ON	Valid	
	20	Hz/PID	PID control cancel	OFF	Valid	Invalid
	21	IVS	Normal/Inverse mode changeover	OFF		
	24	LE	Link operation enable	ON	Invalid	Valid
	33	PID-RST	PID integration/differential reset	OFF	Valid	Invalid
	34	PID-HLD	PID integration hold	OFF		
	98	FWD	Forward operation/stop command	OFF		
	99	REV	Reverse operation/stop command	OFF		

[3] Function data

Table 5.5 Function code and data

Code	Name	Function	Permissible setting range	Min. step	Unit	R/W
S08	Acceleration time F07	Set data with common code numbers and in common communications formats to models.	0.0 to 3600.0	0.1	s	R/W
S09	Deceleration time F08		0.0 to 3600.0	0.1	s	R/W

1) When an attempt is made to enter a value out of the appropriate permissible setting range, an out-of-range error will result.
2) The acceleration time of S08 and the deceleration time of S09 are set to F07 (acceleration time 1) and F08 (deceleration time 1), respectively.
3) The figures below the third place figure of the S08 acceleration time and the S09 deceleration time are omitted within the inverter. (If, for example, 123.4s is written, 123.0s is entered.)

5.1.3 Monitor data

Function codes for monitor data (M codes) are described in the four tables (1 to 4) below. These function codes are for reading only.

Table 5.6 Monitor data function codes (1)

Code	Name	Description	Monitor range	Min. step	Unit
M01	Frequency command (p.u.) (final command)	Frequency command based on the maximum output frequency	-32768 to 32767 (±20,000 = maximum output frequency)	1	-
M05	Frequency command (final command)	Frequency command with min. step 0.01Hz	0.00 to 655.35	0.01	Hz
M06	Output frequency 1 (p.u.)	Output frequency based on the maximum output frequency (before slip compensation)	-32768 to 32767 (±20,000 = maximum output frequency)	1	-
M09	Output frequency 1	Output frequency with min. step 0.01Hz	FGI: -655.35 to 655.35 RTU: 0.00 to 655.35	0.01	Hz
M10	Input power	Power consumption value based on the "nominal applicable motor output" (100%)	0.00 to 399.99	0.01	%
M11	Output current effective value	Output current effective value based on the inverter rated current	0.00 to 399.99 (100% = inverter rated current)	0.01	%
M12	Output voltage effective value	Output voltage effective value (min. step: 1.0V)	0.0 to 1000.0	1.0 *1	V

*1 Since M12 does not have decimal data, its minimum step is 1.0.

Table 5.7 Monitor data function codes (2)

Code	Name	Description	Monitor range	Min. step	Unit
M13	Operation command (final command)	Displays the final command created by information from the keypad, terminal block, and communications, and transmitted to the inverter inside.	0000_H to $FFFF_H$	-	-
M14	Operation status	Displays the operation status in bit signal.	0000_H to $FFFF_H$	-	-
M15	General-purpose output terminal information	General-purpose output terminal information is monitored.	0000_H to $FFFF_H$	-	-
M16	Latest alarm contents	Displays alarm contents in the form of code.	0 to 127	-	-
M17	Last alarm contents				
M18	Second last alarm contents				
M19	Third last alarm contents				
M20	Cumulative operation time	-	0 to 65535	1	h
M21	DC link circuit voltage	Displays the DC link circuit voltage of the inverter.	0 to 1000	1	V
M23	Model code	Displays the series, generation, model, and voltage series in four-digit HEX data.	0000_H to $FFFF_H$	-	-
M24	Capacity code	Displays the capacity of the inverter.	0 to 65535	1	-
M25	ROM version	Displays the ROM version used in the inverter.	0 to 9999	1	-

Table 5.8 Monitor data function codes (3)

Code	Name	Description	Monitor range	Min. step	Unit
M26	Transmission error transaction code	Communications error code of RS485	0 to 127	-	-
M27	Frequency command on alarm (p.u.) (final command)	Data equivalent to M01 on alarm	-32768 to 32767 (±20,000 = maximum output frequency)	1	-
M31	Frequency command on alarm (final command)	Data equivalent to M05 on alarm	0.00 to 655.35	0.01	Hz
M32	Output frequency 1 on alarm (p.u.)	Data equivalent to M06 on alarm	-32768 to 32767 (±20,000 = maximum output frequency)	1	-
M35	Output frequency 1 on alarm	Data equivalent to M09 on alarm	0.00 to 655.35	0.01	Hz
M36	Input power on alarm	Data equivalent to M10 on alarm	0.00 to 399.99	0.01	%
M37	Output current effective value on alarm	Data equivalent to M11 on alarm	0.00 to 399.99 (100% = inverter rated current)	0.01	%
M38	Output voltage effective value on alarm	Data equivalent to M12 on alarm	0.0 to 1000.0	1.0	V
M39	Operation command on alarm	Data equivalent to M13 on alarm	0000_H to $FFFF_H$	1	-
M40	Operation status on alarm	Data equivalent to M14 on alarm	0000_H to $FFFF_H$	1	-

Table 5.9 Monitor data function codes (4)

Code	Name	Description	Monitor range	Min. step	Unit
M41	General-purpose output terminal information on alarm	Data equivalent to M15 on alarm	0000_H to $FFFF_H$	1	-
M42	Cumulative operation time on alarm	Data equivalent to M20 on alarm	0 to 65535	1	h
M43	DC link circuit voltage on alarm	Data equivalent to M21 on alarm	0 to 1000	1	V
M45	Heat sink temperature on alarm	Data equivalent to M62 on alarm	0 to 255	1	°C
M46	Life of main circuit capacitor	The capacity of the main circuit capacitor is 100% when delivered from the plant.	0.0 to 100.0	0.1	%
M47	Life of PC board electrolytic capacitor	Cumulative operation time of the capacitor packaged on the PC board	0 to 65535	1	h
M48	Life of heat sink	Cumulative operation time of the heat sink	0 to 65535	1	h
M49	Input terminal voltage ([12])	Input voltage of terminal [12] (-20,000/-10V, 20,000/10V)	-32678 to 32767	1	-
M50	Input terminal current ([C1])	Input current of terminal [C1] (0/0mA, 20,000/20mA)	0 to 32767	1	-
M62	Heat sink temperature	Current temperature of the heat sink within the inverter	0 to 255	1	°C
M68	PID final command	±20000/±100%	-32678 to 32767	1	-
M69	Inverter rated current	FGI	0.00 to 9999	Variable	A
		RTU	0.00 to 655.35	0.01	A
M70	Operation status 2	Displays the operation status in the form of a bit signal.	0000_H to $FFFF_H$	1	-
M71	Input terminal information	Operation command information from the terminal block and communications	0000_H to $FFFF_H$	1	-

5.1.4 Information displayed on the keypad

The function codes used to read, via RS485, information displayed on the keypad are classified into W codes, X codes, and Z codes. All of these function codes are for read only.

The function codes shown in Tables 5.10 to 5.12 correspond to the menu numbers displayed on the LEDs on the keypad shown in the "LED display" field.

For further information about data displayed on the keypad, see Chapter 3 "OPERATION USING THE KEYPAD" of the FRENIC-Mini Instruction Manual.

RTU and FGI in the Remarks field represent the Modbus RTU protocol and the Fuji general-purpose inverter protocol, respectively.

Table 5.10 Keypad-related function code (W codes)

Code	Name	Monitor range	Min step	Unit	LED display	Remarks
W01	Operation status	0000_H to $FFFF_H$	1	-	*3_07*	
W02	Frequency command	0.00 to 655.35	0.01	Hz	*3_05*	
W03	Output frequency (before slip compensation)	0.00 to 655.35	0.01	Hz	*3_00*	
W04	Output frequency (after slip compensation)	0.00 to 655.35	0.01	Hz	*3_01*	
W05	Output current	0.00 to 9999	Variable	A	*3_02*	FGI
		0.00 to 655.35	0.01	A	*3_02*	RTU
W06	Output voltage	0.0 to 1000.0	0.1	V	*3_03*	
W09	Load rotation speed	0.00 to 99990	Variable	r/min	*3_09*	
W10	Line speed	0.00 to 99990	Variable	m/min	*3_09*	
W11	PID process command	-999 to 999	Variable	-	*3_10*	
W12	PID feedback value	-999 to 999	Variable	-	*3_11*	
W17	Load speed set value	0.00 to 9999	Variable	r/min	Speed monitor	
W18	Line speed set value	0.00 to 9999	Variable	r/min	Speed monitor	
W19	Constant feed time set value	0.00 to 9999	Variable	min	Speed monitor	
W20	Constant feed time	0.00 to 9999	Variable	min	Speed monitor	
W21	Input power	0.00 to 9999	Variable	kW	Operation status monitor	
W27	Timer operation remaining time	0 to 9999	1	s	Operation status monitor	
W28	Operation command source	0 to 22	1	-	-	0 - 3: Same as F02 20: RS 485 Ch1
W29	Frequency command source	0 to 22	1	-	-	0 - 3: Same as F01 20: RS 485 Ch1
W40	Control circuit terminal (input)	0000_H to $FFFF_H$	1	-	*4_00*	
W41	Control circuit terminal (output)	0000_H to $FFFF_H$	1	-	*4_00*	
W42	Communications control signal (input)	0000_H to $FFFF_H$	1	-	*4_01*	
W43	Communications control signal (output)	0000_H to $FFFF_H$	1	-	*4_01*	
W44	Terminal [12] input voltage	0.0 to 12.0	0.1	V	*4_02*	
W45	Terminal [C1] input current	0.0 to 30.0	0.1	mA	*4_03*	
W46	FMA output voltage	0.0 to 12.0	0.1	V	*4_04*	
W70	Cumulative operation time	0 to 65535	1	h	*5_00*	
W71	DC link circuit voltage	0 to 1000	1	V	*5_01*	
W73	Heat sink maximum temperature	0 to 255	1	°C	*5_03*	
W74	Maximum effective current value	0.00 to 9999	Variable	A	*5_04*	
W75	Main circuit capacitor's capacitor	0.00 to 100.0	0.1	%	*5_05*	
W76	Cumulative operation time of electrolytic capacitor on PC board	0 to 65535	1	h	*5_06*	
W77	Cumulative operation time of cooling fan	0 to 65535	1	h	*5_07*	
W78	Number of startups	0 to 65535	1	Times	*5_08*	
W83	Number of RS485 errors	0 to 9999	1	Times	*5_11*	
W84	Contents of RS485 error	0 to 127	1	-	*5_12*	
W87	Inverter's ROM version	0 to 9999	1	-	*5_14*	
W89	Remote keypad's ROM version	0 to 9999	1	-	*5_16*	

Table 5.11 Keypad-related function codes (X codes)

Code	Name	Monitor range	Min. step	Unit	LED display	Remarks
X00	Alarm history (latest)	0000_H to $FFFF_H$	1	1	*6_AL*	Contents of 1 in alarm list (example: 1.OL1)
X01	Multiple alarm 1 (latest)	0000_H to $FFFF_H$	1	1	*6_16*	
X02	Multiple alarm 2 (latest)	0000_H to $FFFF_H$	1	1	*6_17*	
X05	Alarm history (last)	0000_H to $FFFF_H$	1	1	*6_AL*	Contents of 2 in alarm list (example: 2.OC1)
X06	Multiple alarm 1 (last)	0000_H to $FFFF_H$	1	1	*6_16*	
X07	Multiple alarm 2 (last)	0000_H to $FFFF_H$	1	1	*6_17*	
X10	Alarm history (second last)	0000_H to $FFFF_H$	1	1	*6_AL*	Contents of 3 in alarm list (example: 3.OU1)
X11	Multiple alarm 1 (second last)	0000_H to $FFFF_H$	1	1	*6_16*	
X12	Multiple alarm 2 (second last)	0000_H to $FFFF_H$	1	1	*6_17*	
X15	Alarm history (third last)	0000_H to $FFFF_H$	1	1	*6_AL*	Contents of 4 in alarm list (example: 4. LU)
X16	Multiple alarm 1 (third last)	0000_H to $FFFF_H$	1	1	*6_16*	
X17	Multiple alarm 2 (third last)	0000_H to $FFFF_H$	1	1	*6_17*	
X20	Latest information on alarm (output frequency)	0.00 to 655.35	0.01	Hz	*6_00*	
X21	(output current)	0.00 to 9999	Variable	A	*6_01*	FGI
		0.00 to 655.35	0.01	A	*6_01*	RTU
X22	(output voltage)	0 to 1000	1	V	*6_02*	
X24	(set frequency)	0.00 to 655.35	0.01	Hz	*6_04*	
X25	(operation status)	0000_H to $FFFF_H$	1	-	*6_06*	
X26	(cumulative operation time)	0 to 65535	1	h	*6_07*	
X27	(number of startups)	0 to 65535	1	Times	*6_08*	
X28	DC link circuit voltage	0 to 1000	1	V	*6_09*	
X30	(heat sink temperature)	0 to 255	1	°C	*6_11*	
X31	(control circuit terminal (input))	0000_H to $FFFF_H$	1	-	*6_12, 6_13*	
X32	(control circuit terminal (output))	0000_H to $FFFF_H$	1	-	*6_12, 6_14*	
X33	(communications control signal (input))	0000_H to $FFFF_H$	1	-	*6_18, 6_19*	
X34	(communications control signal (output))	0000_H to $FFFF_H$	1	-	*6_18, 6_20*	
X60	Last information on alarm (output frequency)	0.00 to 655.35	1	Hz	*6_00*	
X61	(output current)	0.00 to 9999	Variable	A	*6_01*	FGI
		0.00 to 655.35	0.01	A	*6_01*	RTU
X62	(output voltage)	0 to 1000	1	V	*6_02*	
X64	(set frequency)	0.00 to 655.35	0.01	Hz	*6_04*	
X65	(operation status)	0000_H to $FFFF_H$	1	-	*6_06*	
X66	(cumulative operation time)	0 to 65535	1	h	*6_07*	
X67	(number of startups)	0 to 65535	1	Times	*6_08*	
X68	(DC link circuit voltage)	0 to 1000	1	V	*6_09*	
X70	(heat sink temperature)	0 to 255	1	°C	*6_11*	
X71	(control circuit terminal (input))	0000_H to $FFFF_H$	1	-	*6_12, 6_13*	
X72	(control circuit terminal (output))	0000_H to $FFFF_H$	1	-	*6_12, 6_14*	
X73	(communications control signal (input))	0000_H to $FFFF_H$	1	-	*6_18, 6_19*	
X74	(communications control signal (output))	0000_H to $FFFF_H$	1	-	*6_18, 6_20*	

Table 5.12 Keypad-related function codes (Z codes)

Code	Name	Monitor range	Min. step	Unit	LED display	Remarks
Z00	Second last information on alarm (output frequency)	0.00 to 655.35	1	Hz	*6_00*	
Z01	(output current)	0.00 to 9999	Variable	A	*6_01*	FGI
		0.00 to 655.35	0.01	A	*6_01*	RTU
Z02	(output voltage)	0 to 1000	1	V	*6_02*	
Z04	(set frequency)	0.00 to 655.35	0.01	Hz	*6_04*	
Z05	(operation status)	0000_H to $FFFF_H$	1	-	*6_06*	
Z06	(cumulative operation time)	0 to 65535	1	h	*6_07*	
Z07	(number of startups)	0 to 65535	1	Times	*6_08*	
Z08	(DC link circuit voltage)	0 to 1000	1	V	*6_09*	
Z10	(heat sink temperature)	0 to 255	1	°C	*6_11*	
Z11	(control circuit terminal (input))	0000_H to $FFFF_H$	1	-	*6_12, 6_13*	
Z12	(control circuit terminal (output))	0000_H to $FFFF_H$	1	-	*6_12, 6_14*	
Z13	(communications control signal (input))	0000_H to $FFFF_H$	1	-	*6_18, 6_19*	
Z14	(communications control signal (output))	0000_H to $FFFF_H$	1	-	*6_18, 6_20*	
Z50	Third last information on alarm (output frequency)	0.00 to 655.35	1	Hz	*6_00*	
Z51	(output current)	0.00 to 9999	Variable	A	*6_01*	FGI
		0.00 to 655.35	0.01	A	*6_01*	RTU
Z52	(output voltage)	0 to 1000	1	V	*6_02*	
Z54	(set frequency)	0.00 to 655.35	0.01	Hz	*6_04*	
Z55	(operation status)	0000_H to $FFFF_H$	1	-	*6_06*	
Z56	(cumulative operation time)	0 to 65535	1	h	*6_07*	
Z57	(number of startups)	0 to 65535	1	Times	*6_08*	
Z58	(DC link circuit voltage)	0 to 1000	1	V	*6_09*	
Z60	(heat sink temperature)	0 to 255	1	°C	*6_11*	
Z61	(control circuit terminal (input))	0000_H to $FFFF_H$	1	-	*6_12, 6_13*	
Z62	(control circuit terminal (output))	0000_H to $FFFF_H$	1	-	*6_12, 6_14*	
Z63	(communications control signal (input))	0000_H to $FFFF_H$	1	-	*6_18, 6_19*	
Z64	(communications control signal (output))	0000_H to $FFFF_H$	1	-	*6_18, 6_20*	

5.2 Data Formats

5.2.1 List of data format numbers

The following table shows the communications data format numbers for function code data. Create data according to the data format specifications described below. For data ranges and units, see "Chapter 9 Function Codes" of the FRENIC-Mini User's Manual.

RTU and FGI in the Format number field mean the Modbus RTU protocol and the Fuji general-purpose inverter protocol, respectively.

Table 5.13 List of data format numbers (F codes)

Code	Name	Format number
F00	Data protection	[1]
F01	Frequency setting 1	[1]
F02	Operation method	[1]
F03	Maximum output frequency	[3]
F04	Base frequency	[3]
F05	Base frequency voltage	[1]
F07	Acceleration time 1	[12]
F08	Deceleration time 1	[12]
F09	Torque boost	[3]
F10	Electronic thermal overload relay (for motor protection) (Select)	[1]
F11	Electronic thermal overload relay (for motor protection) (Level)	[24] (FGI) [19] (RTU)
F12	Electronic thermal overload relay (for motor protection) (Thermal time constant)	[3]
F14	Restart mode after momentary power failure (Select)	[1]
F15	Frequency limiter (High)	[3]
F16	Frequency limiter (Low)	[3]
F18	Bias frequency (for F01)	[6]
F20	DC brake (Starting frequency)	[3]
F21	DC brake (Braking level)	[1]
F22	DC brake (Braking time)	[5]
F23	Starting frequency	[3]
F25	Stop frequency	[3]
F26	Motor sound (Carrier frequency)	[1] *1
F27	Motor sound (Sound tone)	[1]
F30	Terminal [FMA] (Output gain)	[1]
F31	Terminal [FMA] (Function)	[1]
F37	Load select/automatic torque boost/automatic energy-saving operation	[1]
F43	Current limiting (Mode)	[1]
F44	Current limiting (Level)	[1]
F50	Electronic thermal overload relay (Discharging capability)	[1] *2
F51	Electronic thermal overload relay (Permissible loss)	[7]

*1 The frequency of 0.75kHz will be treated as 0.

*2 The value of 999 will be treated as $7FFF_H$.

Table 5.14 List of data format numbers (E codes)

Code	Name	Format number
E01	[X1] terminal function (Select)	[1]
E02	[X2] terminal function (Select)	[1]
E03	[X3] terminal function (Select)	[1]
E10	Acceleration time 2	[12]
E20	[Y1] terminal function (Select)	[1]
E27	[30A, B, C] (relay output) (Select)	[1]
E31	Frequency detection 1 (FDT) (Level)	[3]
E34	Overload early warning/current detection/low level (Level) current detection	[24] (FGI) [19] (RTU)
E35	Overload early warning/current detection/low level (Timer) current detection	[5]
E39	Coefficient of constant rate of feeding time	[7]
E40	PID display coefficient A	[12]
E41	PID display coefficient B	[12]
E43	LED monitor (Select)	[1]
E45	*1	[1]
E46	*1	[1]
E47	*1	[1]
E48	Details of LED monitor (Speed monitor select)	[1]
E50	Speed display coefficient	[5]
E52	Keypad (Mode selection)	[1]
E60	Potentiometer on the keypad (Function selection)	[1]
E61	Terminal [12] (Function)	[1]
E62	Terminal [C1] (Function)	[1]
E98	Terminal [FWD] (Function)	[1]
E99	Terminal [REV] (Function)	[1]

*1 Although E45 to E47 are displayed, the FRENIC-Mini does not use them. Do not change the settings.

Table 5.15 List of data format numbers (C codes)

Code	Name	Format number
C01	Jump frequency 1	[3]
C02	Jump frequency 2	[3]
C03	Jump frequency 3	[3]
C04	Jump frequency (Hysteresis)	[3]
C05	Multistep frequency 1	[5]
C06	Multistep frequency 2	[5]
C07	Multistep frequency 3	[5]
C08	Multistep frequency 4	[5]
C09	Multistep frequency 5	[5]
C10	Multistep frequency 6	[5]
C11	Multistep frequency 7	[5]
C20	Jogging frequency	[5]
C21	Timer operation (Operation selection)	[1]
C30	Frequency setting 2	[1]
C32	Analog input adjustment (terminal [12]) (Gain)	[5]
C33	Analog input adjustment (terminal [12]) (Filter)	[5]
C34	Analog input adjustment (terminal [12]) (Gain reference point)	[5]
C37	Analog input adjustment (terminal [C1]) (Gain)	[5]
C38	Analog input adjustment (terminal [C1]) (Filter)	[5]
C39	Analog input adjustment (terminal [C1]) (Gain reference point)	[5]
C50	Bias (frequency setting 1) (Bias reference point)	[5]
C51	Bias (PID command 1) (Bias value)	[6]
C52	Bias (PID command 1) (Bias reference point)	[5]

Table 5.16 List of data format numbers (P codes)

Code	Name		Format number
P02	Motor (Capacity)	When P99 = 0, 3 or 4	[11]
		When P99 = 1	[25]
P03	Motor (Rated current)		[24] (FGI)
			[19] (RTU)
P09	Motor (Slip compensation gain)		[3]
P99	Motor select		[1]

Table 5.17 List of data format numbers (H codes)

Code	Name	Format number
H03	Data initialization	[1]
H04	Retry (Number of times)	[1]
H05	Retry (Waiting time)	[3]
H06	Cooling fan ON-OFF control	[1]
H07	Curved acceleration/deceleration	[1]
H12	Instantaneous overcurrent limit	[1]
H26	PTC thermistor input (Operation selection)	[1]
H27	PTC thermistor (Operation level)	[5]
H30	Link function (Function selection)	[1]
H42	Main circuit capacitor's capacity	[1]
H43	Cumulative operation time of cooling fan	[1]
H50	Non-linear V/f (Frequency)	[3]
H51	Non-linear V/f (Voltage)	[1]
H54	Acceleration/Deceleration time (Jogging operation)	[12]
H64	Low limiter (Minimum frequency during limited operation)	[3]
H69	Automatic deceleration (Operation selection)	[1]
H70	Overload prevention control	[5] *1
H80	Current oscillation suppression gain	[5]
H96	STOP key priority/start check function	[1]
H97	Alarm data clear	[1]
H98	Protection/Maintenance function (Select)	[1]

*1 The value of 999 will be treated as $7FFF_H$.

Table 5.18 List of data format numbers (J codes)

Code	Name	Format number
J01	PID control (Operation selection)	[1]
J02	PID control (Remote process command)	[1]
J03	PID control P (Gain)	[7]
J04	PID control I (Integration time)	[3]
J05	PID control D (Differentiation time)	[5]
J06	PID control (Feedback filter)	[3]

Table 5.19 List of data format numbers (y codes)

Code	Name	Format number
y01	RS485 setting (Station address)	[1]
y02	RS485 setting (Operation selection on error)	[1]
y03	RS485 setting (Timer)	[3]
y04	RS485 setting (Baud rate)	[1]
y05	RS485 setting (Data length)	[1]
y06	RS485 setting (Parity check)	[1]
y07	RS485 setting (Stop bits)	[1]
y08	RS485 setting (No response error detection time)	[1]
y09	RS485 setting (Response interval)	[5]
y10	RS485 setting (Protocol select)	[1]
y99	Link function for supporting data input (Select)	[1]

Table 5.20 List of data format numbers (S codes)

Code	Name	Format number
S01	Frequency command (p.u.)	[29]
S05	Frequency command	[22]
S06	Operation command	[14]
S08	Acceleration time	[3]
S09	Deceleration time	[3]
S13	PID command	[29]
S14	Alarm reset command	[1]

Table 5.21 List of data format numbers (M codes)

Code	Name	Format number
M01	Frequency command (p.u.) (final command)	[29]
M05	Frequency command (final command)	[22]
M06	Output frequency 1 (p.u.)	[29]
M09	Output frequency 1	[23] (FGI) [22] (RTU)
M10	Input power	[5]
M11	Output current effective value	[5]
M12	Output voltage effective value	[3]
M13	Operation command (final command)	[15]
M14	Operation status	[16]
M15	General-purpose output terminal information	[15]
M16	Latest contents of alarm	[10]
M17	First last contents of alarm	[10]
M18	Second last contents of alarm	[10]
M19	Third last contents of alarm	[10]
M20	Cumulative operation time	[1]
M21	DC link circuit voltage	[1]
M23	Model code	[17]
M24	Capacity code When P99 = 0, 3 or 4 When P99 = 1	[11] [25]
M25	ROM version	[35]
M26	Transmission error transaction code	[20]
M27	Frequency command on alarm (p.u.) (final command)	[29]
M31	Frequency command on alarm (final command)	[22]
M32	Output frequency on alarm 1 (p.u.)	[29]
M35	Output frequency on alarm 1	[23] (FGI) [22] (RTU)
M36	Power consumption on alarm	[5]
M37	Output current effective value on alarm	[5]
M38	Output voltage effective value on alarm	[3]
M39	Operation command on alarm	[14]
M40	Operation status on alarm	[16]
M41	General-purpose output terminal information on alarm	[15]
M42	Cumulative operation time on alarm	[1]
M43	DC link circuit voltage on alarm	[1]
M45	Heat sink temperature on alarm	[1]
M46	Life of main circuit capacitor	[3]
M47	Life of PC board electrolytic capacitor	[1]
M48	Life of cooling fan	[1]
M49	Input terminal voltage ([12])	[29]
M50	Input terminal current ([C1])	[29]
M62	Heat sink temperature	[1]
M68	PID final command	[29]
M69	Inverter rated current	[24] (FGI) [19] (RTU)
M70	Operation status 2	[44]
M71	Operation command	[14]

Table 5.22 List of data format numbers

Code	Name	Format number
W01	Operation status	[16]
W02	Frequency command	[22]
W03	Output frequency (before slip)	[22]
W04	Output frequency (after slip)	[22]
W05	Output current	[24] (FGI) [19] (RTU)
W06	Output voltage	[3]
W09	Load rotation speed	[37]
W10	Line speed	[37]
W11	PID process command	[12]
W12	PID feedback value	[12]
W17	Load speed set value	[37]
W18	Line speed set value	[37]
W19	Constant rate of feeding time	[37]
W20	Constant rate of feeding time	[37]
W21	Input power	[24]
W27	Timer operation remaining time	[1]
W28	Operation command source	[1]
W29	Frequency command source	[1]
W40	Control circuit terminal (input)	[43]
W41	Control circuit terminal (output)	[15]
W42	Communications control signal (input)	[14]
W43	Communications control signal (output)	[15]
W44	Terminal [12] input voltage	[3]
W45	Terminal [C1] input current	[3]
W46	FMA output voltage	[3]
W70	Cumulative operation time	[1]
W71	DC link circuit voltage	[1]
W73	Heat sink maximum temperature	[1]
W74	Maximum effective current value	[24]
W75	Main circuit capacitor's capacity	[3]
W76	Cumulative operation time of PC board electrolytic capacitor	[1]
W77	Cumulative operation time of cooling fan	[1]
W78	Number of startups	[1]
W83	Number of RS485 errors	[1]
W84	Contents of RS485 error	[20]
W87	Inverter's ROM version	[35]
W89	Remote keypad's ROM version	[35]

Table 5.23 List of data format numbers (X codes)

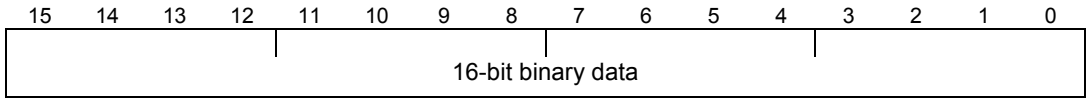
Code	Name	Format number
X00	Alarm history (latest)	[41]
X01	Multiple alarm 1 (latest)	[40]
X02	Multiple alarm 2 (latest)	[40]
X05	Alarm history (last)	[41]
X06	Multiple alarm 1 (last)	[40]
X07	Multiple alarm 2 (last)	[40]
X10	Alarm history (second last)	[41]
X11	Multiple alarm 1 (second last)	[40]
X12	Multiple alarm 2 (second last)	[40]
X15	Alarm history (third last)	[41]
X16	Multiple alarm 1 (third last)	[40]
X17	Multiple alarm 2 (third last)	[40]
X20	Latest information on alarm (output frequency)	[22]
X21	(output current)	[24] (FGI) [19] (RTU)
X22	(output voltage)	[3]
X24	(set frequency)	[22]
X25	(operation status)	[16]
X26	(cumulative operation time)	[1]
X27	(number of startups)	[1]
X28	(DC link circuit voltage)	[1]
X30	(heat sink temperature)	[1]
X31	(control circuit terminal (input))	[43]
X32	(control circuit terminal (output))	[15]
X33	(communications control signal (input))	[14]
X34	(communications control signal (output))	[15]
X60	Last information on alarm (output frequency)	[22]
X61	(output current)	[24] (FGI) [19] (RTU)
X62	(output voltage)	[3]
X64	(set frequency)	[22]
X65	(operation status)	[16]
X66	(cumulative operation time)	[1]
X67	(number of startups)	[1]
X68	(DC link circuit voltage)	[1]
X70	(heat sink temperature)	[1]
X71	(control circuit terminal (input))	[43]
X72	(control circuit terminal (output))	[15]
X73	(communications control signal (input))	[14]
X74	(communications control signal (output))	[15]

Table 5.24 List of data format numbers (Z codes)

Code	Name	Format number
Z00	Second last information on alarm (output frequency)	[22]
Z01	(output current)	[24] (FGI) [19] (RTU)
Z02	(output voltage)	[1]
Z04	(set frequency)	[22]
Z05	(operation status)	[16]
Z06	(cumulative operation time)	[1]
Z07	(number of startups)	[1]
Z08	(DC link circuit voltage)	[1]
Z10	(heat sink temperature)	[1]
Z11	(control circuit terminal (input))	[43]
Z12	(control circuit terminal (output))	[15]
Z13	(communications control signal (input))	[14]
Z14	(communications control signal (output))	[15]
Z50	Third last information on alarm (output frequency)	[22]
Z51	(output current)	[24] (FGI) [19] (RTU)
Z52	(output voltage)	[1]
Z54	(set frequency)	[22]
Z55	(operation status)	[16]
Z56	(cumulative operation time)	[1]
Z57	(number of startups)	[1]
Z58	(DC link circuit voltage)	[1]
Z60	(heat sink temperature)	[1]
Z61	(control circuit terminal (input))	[43]
Z62	(control circuit terminal (output))	[15]
Z63	(communications control signal (input))	[14]
Z64	(communications control signal (output))	[15]

5.2.2 Data format specifications

The data in the data fields of a communications frame are 16 bits long, binary data, as shown below.



For the convenience of description, 16-bit data is expressed in hexadecimal with one upper-order byte (eight bits from 15 to 8) and one lower-order byte (eight bits from 7 to 0).

For example, the following data is 1234H in hexadecimal and expressed as | 12_H | 34_H | .

0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Data format [1] Integer data (positive): Minimum step 1

(Example) When F15 (frequency limiter (upper limit)) = 60Hz

60 = $003C_H$ Consequently, ⇒ | 00_H | $3C_H$ |

Data format [2] Integer data (positive/negative): Minimum step 1

(Example) When the value is -20

-20 = $FFEC_H$ Consequently, ⇒ | FF_H | EC_H |

Data format [3] Decimal data (positive): Minimum step 0.1

(Example) When F17 (gain frequency set signal) = 100.0%

100.0 x 10 = 1000 = $03E8_H$ Consequently, ⇒ | 03_H | $E8_H$ |

Data format [4] Decimal data (positive/negative): Minimum step 0.1

(Example) When C31 (analog input offset adjustment) = -5.0%

-5.0 x 10 = -50 = $FFCE_H$ Consequently, ⇒ | FF_H | CE_H |

Data formant [5] Decimal data (positive): Minimum step 0.01

(Example) C05 (multistep frequency) = 50.25Hz

50.25 x 100 =5025 =$13A1_H$. Consequently, ⇒ | 13_H | $A1_H$ |

Data format [6] Decimal data (positive/negative): Minimum step 0.01

(Example) When M07 (actual torque value) = -85.38%

-85.38 x 100 =-8538 = $DEA6_H$ Consequently, ⇒ | DE_H | $A6_H$ |

Data format [7] Decimal data (positive): Minimum step 0.001

(Example) When F51(electronic thermal (permissible loss)) = 0.105kW

$0.105 \times 1000 = 105 = 0069_H$ Consequently, ⇒

00_H	69_H

Data formant [8] Decimal data (positive/negative): Minimum step 0.001

(Example) When the data is -1.234

$-1.234 \times 1000 = -1234 = FB2E_H$ Consequently, ⇒

FB_H	$2E_H$

Data format [10] Alarm codes

Table 5.25 List of alarm codes

Code	Description		Code	Description	
0	No alarm	---	20	Motor protection (PTC thermistor)	*OH4*
1	Overcurrent protection (during acceleration)	*OC1*	22	Overheat protection (braking resistor)	*dbH*
2	Overcurrent protection (during deceleration)	*OC2*	23	Motor protection (electronic thermal overload relay	*OL1*
3	Overcurrent protection (during constant speed operation)	*OC3*	25	Overload protection	*OLU*
6	Overvoltage protection (during acceleration)	*OU1*	31	Memory error	*Er1*
7	Overvoltage protection (during deceleration)	*OU2*	32	Remote keypad communications error	*Er2*
8	Overvoltage protection (during constant speed operation or stopping)	*OU3*	33	CPU error	*Er3*
10	Undervoltage protection	*LU*	36	Operation protection	*Er6*
11	Input phase loss protection	*Lin*	38	RS485 communications error	*Er8*
17	Overheat protection (inverter)	*OH1*	46	Output phase loss protection	*OPL*
18	External alarm input	*OH2*	51	Data save error in case of undervoltage	*ErF*

(Example) In the case of overvoltage protection (during acceleration) (*OU1*)

$6 = 0006_H$ Consequently, ⇒

00_H	06_H

Data format [11] Capacity code (unit: kW)

As shown in the table below, the capacity (kW) is multiplied by 100.

Table 5.26 Capacities and data

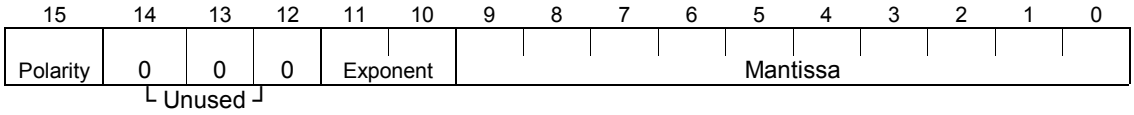
Capacity (kW)	0.06	0.1	0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11
Data	6	10	20	40	75	150	220	370	550	750	1100

(Example) When the capacity is 2.2 kW

2.20 x 100 = 220 = $00DC_H$ Consequently, ⇒

00_H	DC_H

Data format [12] Floating point data (accel./decal. time, PID display coefficient)



Polarity: 0 → Positive (+), 1 → Negative (-) Exponent: 0 to 3 Mantissa: 1 to 999

Value expressed in this form = (polarity) Mantissa x (Exponent - 2) power of 10

Value	Mantissa	Exponent	(Exponent - 2) power of 10
0.00 to 9.99	001 to 999	0	0.01
10.0 to 99.9	100 to 999	1	0.1
100 to 999	100 to 999	2	1
1000 to 9990	100 to 999	3	10

(Example) When F07 (acceleration time 1) = 20.0 seconds

20.0 = 200 x 0.1 => 0000 0100 1100 1000b = $04C8_H$ ⇒ Consequently,

04_H	$C8_H$

Data format [14] Operation command

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RST	XR (REV)	XF (FWD)	0	0	0	0	0	0	0	0	X3	X2	X1	REV	FWD
↑	General-purpose input		Unused		General-purpose input									FWD: Forward command	
Alarm reset														REV: Reverse command	

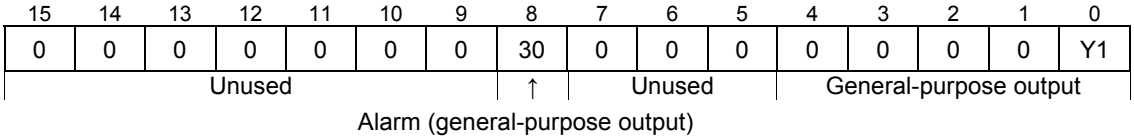
(All bits are turned ON when set to 1.)

(Example) When S06 (operation command) = FWD, X1 = ON

$0000\ 0000\ 0000\ 0101_b = 0005_H$ Consequently, ⇒

00_H	05_H

Data format [15] General-purpose output terminal



(All bits are turned ON when set to 1.)

(Example) When M15 (general-purpose output terminal) = Y1 = ON

$0000\ 0000\ 0000\ 0001_b = 0001_H$ Consequently, ⇒

00_H	01_H

Data format [16] Operation status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	0	0	RL	ALM	DEC	ACC	IL	VL	0	NUV	0	INT	EXT	REV	FWD

(All bits are turned ON or become active when set to 1.)

FWD : During forward rotation
REV : During reverse rotation
EXT : During DC braking (or during pre-exciting)
INT : Inverter shut down
NUV : DC link circuit voltage established (0 = undervoltage)
VL : During voltage limiting
IL : During current limiting
ACC : During acceleration
DEC : During deceleration
ALM : Alarm relay (for any fault)
RL : Communications effective
BUSY : During function code data writing

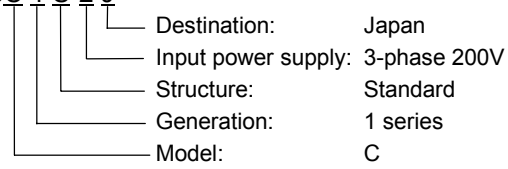
Data format [17] Model code

15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0
Model	Generation	Destination	Input power supply

Table 5.27 List of model codes

Code	1	2	3	4	5	6	7	8	9	A	B
Model	VG	G	P	E	C	S	DPS	DGS	H (1667Hz)	H (3000Hz)	F
Generation	11 series	7 series	1 series								
Destination	Japan (standard)	Asia	China	Europe	U.S.A.						
Input power supply	Single-phase 100V	Single-phase 200V	Three-phase 200V	Three-phase 400V							

(Example) When the inverter type is FRN1.5C 1 S-2 J



Since "model ":C is represented by code 5, "generation": 1 series by code 3, "destination": Japan (standard) by 1, and "input power supply": 3-phase 200V by 3, the model code is 5313_H.

Data format [19] Current value [decimal data (positive): Min. step 0.01]

(Example) When F11 (electronic thermal OL relay operation level) = 3.60A

3.60 x 100 = 360 = 0168_H Consequently, ⇒

01_H	68_H

Data format [20] Communications error

Table 5.28 Communications error codes (common to both protocols)

Code	Description	Code	Description
71	Checksum error, CRC error ⇒ No response	73	Framing error, overrun error, buffer full ⇒ No response
72	Parity error ⇒ No response		

Table 5.29 Communications error codes (for Fuji general-purpose inverter protocol)

Code	Description	Code	Description
74	Format error	78	Function code error
75	Command error	79	Write disabled
76	Link priority error	80	Data error
77	Function code data write right error	81	Error during writing

Table 5.30 Communications error codes (for RTU protocol)

Code	Description	Code	Description
1	Improper FC	3	Improper data (range error)
2	Improper address (function code error)	7	NAK (link priority, no right, write disabled)

(Example) In case of an improper address

$2 = 0002_H$ Consequently, ⇒

00_H	02_H

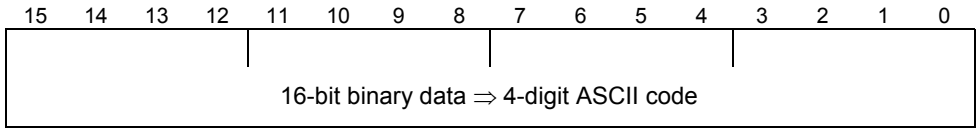
Data format [22] Frequency data

Floating point data (positive): Resolution 0.01Hz

Data format [23] Polarity + decimal data (positive)

(for Fuji general-purpose inverter protocol)

Decimal data (positive): Resolution 0.01Hz



For reverse rotation, add a negative sign (-) (ASCII) to the special additional data in the standard frame, or for forward rotation, enter a space (ASCII).

(Example) When maximum output frequency = 60Hz and M09 (output frequency) = 60.00Hz (forward rotation)

$60.00 \times 100 = 6000 = 1770_H$ Consequently, ⇒

	1	7	7	0

(Positive data is in the same data format as data format [5].)

Data format [24] Floating point data

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent		Mantissa													

0 : 0.01 ×000 to 9999 (0.00 to 99.99)
1 : 0.1 ×100 to 9999 (100.0 to 999.9)
2 : 1 ×100 to 9999 (1000 to 9999)
3 : 10 ×100 to 9999 (10000 to 99990)

See the description of data format [12].

Data format [25] Capacity code (for HP)

As shown in the table below, the capacity (HP) is multiplied by 100.

Table 5.31 Capacities and data (for HP)

Capacity (HP)	0.07	0.15	0.25	0.5	1	2	3	5	7.5	10
Data	7	15	25	50	100	200	300	500	750	1000

(Example) When the capacity is 3HP

3 x 100 = 300 = $012C_H$ Consequently, ⇒

01_H	$2C_H$

Data format [29] Positive/Negative data of values converted into p.u. (standard) with 20,000

(Example) Speed (frequency) Data of ±20,000/±maximum speed (frequency)

Data format [35] ROM version

Range: 0 to 9999

Data format [37] Floating point data (load rotation speed, etc.)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent		Mantissa													

0 : 0.01 ×000 to 9999 (0.00 to 99.99)
1 : 0.1 ×100 to 9999 (100.0 to 999.9)
2 : 1 ×100 to 9999 (1000 to 9999)
3 : 10 ×100 to 9999 (10000 to 99990)

See the description of data format [12].

Data format [40] Alarm cause

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Number of multiple occurrences (1 to 5)				Occurrence sequence (1 to 5)				Alarm code (See Table 5.25.)							

Data format [41] Alarm history

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Number of serial occurrences of same alarm								Alarm code (See Table 5.25.)							

Data format [43] Operation command (for I/O check)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	X3	X2	X1	REV	FWD
Unused						General-purpose input								General-purpose input	

(All bits are turned ON when set to 1.)

Data format [44] Operation status 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	IDL	ID	OLP	LIFE	0	TRY	0	0	OL	IPF	0	0	FDT	FAR

(All bits are turned ON or become active when set to 1.)

FAR: Frequency equivalence
FDT: Frequency detection
IPF: During restart after instantaneous power failure
OL: Motor overload
TRY: During retry
LIFE: Life warning
OLP: During active drive
ID: Current detection
IDL: Low current detection

For further information, see "5.2 Overview of Function Codes" in Chapter 5 of the FRENIC-Mini Instruction Manual.

COMPACT INVERTER

FRENIC-Mini

User's Manual for RS485 Communications Card

First edition: October 2002

Fuji Electric Co., Ltd.

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